

PIP



GUIDE TO GOOD CROP PROTECTION PRACTICES

FOR 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*

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www.coleacp.org/pip



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Programme PIP
COLEACP
Rue du Trône, 130 - B-1050 Brussels - Belgium
Tel.: +32 (0)2 508 10 90 - Fax: +32 (0)2 514 06 32

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AG-TECH Consult

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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 EU Directive 91/414, which must comply with European standards for pesticide residues. Currently, these active substances have not been tested by PIP in ACP countries to check their conformity with European 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.

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

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1. Main enemies of cucurbits

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 fruit 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 fruits per plant, smaller-sized fruits, lower quality of fruits.

Quarantine organisms in Europe are followed by the abbreviation "QQ".

INSECTS						
Extent	Organs attacked		Types of losses			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Leaf-eating beetles - <i>Chrysomelidae</i> <i>Aulacophora africana</i> , <i>Monolepta</i> spp., <i>Acalymma vittata</i> , <i>Diabrotica undecimpunctata</i> QQ, <i>Asbecesta cyanipennis</i> , <i>Asbecesta transversa</i>						
The most significant losses are not related directly to the feeding of the beetles, but to the transmission of bacterial wilt (<i>Erwinia tracheiphila</i>). Bacterial wilt kills the plant, resulting in a significant decrease in yield.						
+	Holes bored by adults in leaves and flowers Stem near ground and roots can also be attacked by larvae	Peel eaten	Young plants die if attacked severely			Market value reduced
African melon ladybird beetle - <i>Henosepilachna elaterii</i>						
+		Eaten by adults and larvae	Young plants die if attacked severely			
Webworm - <i>Diaphania(Margaronia) indica</i>, <i>Diaphania nitida</i>						
+	Eaten by larvae	Skin eaten by larvae		Reduced if photosynthesis is significantly slowed due to the presence of high number of holes on leaves.		Market value reduced

INSECTS (continued)

Extent	Organs attacked		Types of losses			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Fruit fly <i>Dacus vertebratus</i> , <i>Dacus ciliatus</i> QO, <i>Bactrocera cucurbitae</i> QO, <i>Bactrocera invadens</i> , <i>Bactrocera latifrons</i> , <i>Bactrocera zonata</i> QO						
+++		Larvae in fruit		Sharp decrease if fruit attacked at early stage		Fruit rots from inside or quality reduced due to punctures
American Leafminer - <i>Liriomyza trifolii</i> QO						
++	Bitten into by adults and mined by larvae			Reduced if photosynthesis is significantly slowed due to extensive mining		
White Fly - <i>Bemisia tabaci</i> QO						
+++	Bitten into by adults and larvae			Reduced if photosynthesis is significantly slowed due to the presence of sooty mould that develops on the honeydew secreted by larvae		Honeydew depreciates market value of fruit
Thrips <i>Ceratothripoides cameroni</i> <i>Frankliniella occidentalis</i> QO <i>Thrips</i> sp						
+++	Eaten by adults and larvae			Significant reduction if growth is slowed by severe attacks on young plants		Deformations of fruits
Melon Aphid - <i>Aphis gossypii</i>						
This aphid carries viruses that can cause a significantly reduced yield. A severe viral infection can even lead to the total loss of the crop.						
+++	Bitten into by adults and larvae			Significant reduction if growth is slowed by severe attacks		
MITES						
Extent	Organs attacked		Types of losses			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Red Spider Mite - <i>Tetranychus urticae</i>						
+++	Eaten by adults and larvae			Reduced if attack is severe		

NEMATODES

Extent	Organs attacked		Types of losses		
	Roots	Number of plants	Number of fruits/plant	Size of fruits	Quality of fruits at maturity
Root-knot nematode - <i>Meloidogyne</i> spp.					
The presence of <i>Meloidogyne</i> favours or aggravates attacks of fungi such as <i>Fusarium</i> (resistance break). Infested plants are very sensitive to drought or irregular irrigation.					
+++	Deformed by galls	Plant will die if attacked at early stage	Significant reduction if growth is slowed by severe attack at early stage		

FUNGI

Extent	Organs attacked		Types of losses			
	Stem	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Fusarium wilt <i>Fusarium oxysporum</i> f.sp. <i>cucumerinum</i> <i>Fusarium solani</i>						
Before the discovery of resistant varieties, the fungus could cause a total loss of the crop.						
++	Development of mycelium inside the stem		Loss of young plants through damping-off, or of older plants through successive wilting		If fruit has formed, it remains small and loses commercial value	
Gummy stem blight – Black rot - Canker <i>Didymella bryoniae</i> (<i>Cercospora citrullina</i>)						
+	Development of mycelium in stem, leaves and fruits		Loss of plants if heavy infestation	Reduced if photosynthesis is significantly slowed due to the presence of the fungus		Fruits rot
Anthracoze - <i>Colletotrichum orbiculare</i> (<i>lagenarium</i>)						
+		Presence of the fungus on upper and lower surfaces Fruits could be also infested		Reduced if photosynthesis is significantly slowed due to the presence of the fungus		Fruits rot
Powdery mildew <i>Sphaerotheca fuliginea</i> <i>Erysiphe cichoracearum</i>						
+++		Presence of the fungus on upper and lower surfaces	Premature death of plants	Reduced if photosynthesis is significantly slowed due to the presence of the fungus		

FUNGI (continued)

Extent	Organs attacked		Types of losses			
	Stem	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Downy mildew - <i>Pseudoperonospora cubensis</i>						
+		Presence of the fungus on upper and lower surfaces	Premature death of plants	Reduced if photosynthesis is significantly slowed due to the presence of the fungus		
Stem and collar rot - <i>Pythium aphanidermatum</i>						
+	Development of mycelium inside the stem		Loss of young plants through damping-off			
Scab of cucurbits - <i>Cladosporium cucumerinum</i>						
+	Development of mycelium in stem, leaves and fruits		If young plants are infected, the stem and leaves collapse quickly			My lead to important damages to fruits that eventually rot

BACTERIA

Extent	Organs attacked		Types of losses			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Angular leaf spot - <i>Pseudomonas syringae</i> pv. <i>lachrymans</i>						
Before the discovery of resistant varieties, the fungus could cause a total loss of the crop						
+	Presence of lesions on the upper surface of leaves	Presence of lesions on fruit		Reduced if photosynthesis is significantly slowed due to the presence of lesions on the leaves		Commercial value reduced

VIRUS

Extent	Organs attacked		Types of losses			
	Whole plant		Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Cucumber mosaic - CMV (Cucumber Mosaic Virus)						
++	Once transmitted the virus is spread in all the plant			Significant reduction if growth is slowed by severe attack at early stage		
Zucchini yellow mosaic virus - ZYMV (Zucchini Yellow Mosaic virus)						
+++	Once transmitted the virus is spread in all the plant			Significant reduction if growth is slowed by severe attack at early stage		

The virus is transmitted from one plant to another by aphids (*Aphis gossypii*, etc.). The transmission mode is of the non-persistent type: the aphids acquire the virus on an infected plant and then transmit it to a healthy plant with their bites. They are capable of infecting a healthy plant for several hours, but lose this capacity quickly when biting healthy plants repeatedly.

1.2. Identification and damage

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

INSECTS

Chrysomelidae

Adults bore small holes in the leaves.

Larvae feed on the collar under the surface of the ground, and can even penetrate the main root, often causing the death of seedlings.



Aulacophora africana



Monolepta sp.



Diabrotica



Acalymma

African melon ladybird beetle - *Henosepilachna elaterii*

Adults and larvae are often found on the lower surface of leaves. They damage the leaves by "scraping" and devouring the parenchyma and the lower epidermis between the veins, leaving one of the two surfaces intact (often the upper epidermis), as well as the tougher tissues (veins, etc.), in the form of a "window". The affected leaves become translucent, take on a greyish colour and dry up. The young plants can dry up completely and die in cases of severe attack. Zucchini are more sensible than melon.



Larva



Adult

Webworm - *Diaphania (Margaronia) indica*, *Diaphania nitida*

The caterpillars devour the foliage and eat into or make holes in the peel.



Caterpillars

Fruit flies - *Dacus* spp. et *Bactrocera* spp.

The females pierce the skin of very young fruit to lay a dozen or so eggs just beneath the skin. The skin of older fruits is too tough for the insect to pierce. The egg-laying area turns brown, softens and becomes sunken. After hatching, the maggots burrow and feed on the pulp of the fruit, often leading to soft rot of all or part of the fruit in cases of serious infestation. Small fruits are deformed and rot if attacked. They are covered with small tunnels. The holes pierced in the fruit can be places of entry for secondary pathogens (fungi, bacteria).



Damages on fruits of cucumber



Damages on fruits of cucumber



Larvae in the fruit of zucchini



Dacus sp.



Bactrocera invadens

For more information fruit flies identification one can consult the web site <http://www.africamuseum.be/fruitfly/AfroAsia.htm>

American Leaf Miner - *Liriomyza trifolii*

Introduced in Africa 20 years ago, this pest has a wide range of hosts. The larvae bore winding tunnels inside the leaves and cotyledons. The tunnels widen as the larvae develop. They turn brown with time and look like leaf spots.



Mines on leaves



White fly - *Bemisia tabaci*

Serious infestations of white fly on young plants can cause the leaves to dry up. The fruit and leaves are contaminated by the secretion of honeydew, on which sooty mould develops, slowing the plant's photosynthesis. Very polyphagous insect.

Thrips - *Ceratothripoides cameroni* *Frankliniella occidentalis*

They cause deformations of the terminal buds of the plants and stunt their growth. The most serious damage is due to the egg-laying lesions. Feeding cause damages not by the fact of punctures but by deformations due to saliva injected. The tissues on which the thrips feeds become leaden in appearance and "speckled"; they are severely discoloured, particularly the petals.

Aphids - *Aphis gossypii*

Aphids such as *A. gossypii* feed on plant sap using mouthparts called "stylets", which penetrate the intercellular tissues. They can colonise a crop in just a few days. Young shoots and leaves are preferred. After being injected with the aphid's toxic saliva, the leaf or shoot turns yellow, becomes puckered and deformed, curling downward. Shoots are shortened. *A. gossypii* is generally found in large colonies on the lower surface of young leaves or on young shoots. The aphids secrete a sugary substance (honeydew) on which sooty mould develops, altering the photosynthetic function of the leaves.

A. gossypii can also transmit numerous viruses, including cucumber mosaic virus (CMV) or the zucchini yellow mosaic virus (ZYMV).



Curled leaves on cucumber

MITES

Red spider mite - *Tetranychus urticae*

Mites live on the underside of leaves and suck out sap by making minuscule holes. They are visible to the naked eye in the form of small red, moving "balls", but their small size makes them difficult to detect until damage is observed. The first sign of spider mite infestation appears on the upper surface of leaves in the form of small yellowish white spots. This is often accompanied by deformation and drying up of the attacked organs. The leaf can also be covered with webbing.

They are polyphagous and all stages (larvae, nymphs and adults) are harmful.



Symptoms on the upper face of a cucumber leaf



Mites on the underleaf



Webbing on a zucchini leaf



Symptoms on the upper face of a zucchini leaf

NEMATODES**Root-knot nematode - *Meloidogyne* spp.**

Root-knot nematodes cause the formation of galls on the roots of plants. These irregular swellings, often round-shaped, result from root cell hypertrophy caused by the enzymes secreted by the stylet of nematode larvae. When the galls are opened, small whitish balls, measuring at most 1 mm in diameter, can be seen. These are the female nematodes. The main roots are deformed. The reduction of the secondary root system and the disruption to the conductor vessels and the plant's metabolism hinder the plant's ability to take in water and nutrients. It is therefore more susceptible to drought, grows more slowly, has fewer and chlorotic leaves, and smaller and fewer fruits. The plant dies in cases of severe infestation. Nematode infestation can also provide a place of entry for bacteria and fungi present in soil (e.g. *Fusarium*).

The zucchini seems to be less sensible than melon or cucumber.



FUNGI

Wilt or fusariosis - *Fusarium solani*, *Fusarium oxysporum* f. sp. *cucumerinum*

The fungus infects the crop at all stages of development.

Young plants and even older ones wilt. The fungus invades the conductor vessels of the main stem, disrupting the plant's nutrition.

The leaves turn yellow. The plants seem to fall over.

Dry rot can be seen on the stem at ground level. It is followed by a general wilting of the plant and its death, generally occurring just before the start of harvest. A mild infection causes tears in the epidermis at the collar of the plant. A severe attack causes rot in the roots and stem at ground level. The tissues in the upper part of the stems do not turn brown. All the stem tissue dies and becomes spongy.

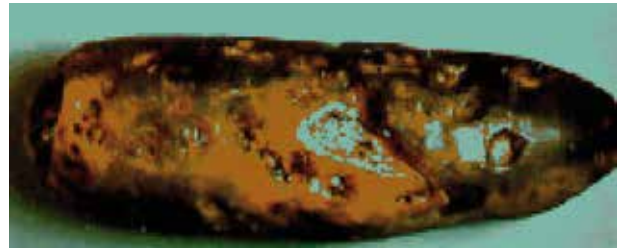
Fusarium destroys the vascular vessels and disrupts the plant's ability to absorb water. Infected plants bearing fruit wilt on sunny days but can recover during the night. They die after several successive wilts. The diseased stems constitute sources of infection in the plot.

Anthracoze - *Colletotrichum orbiculare* (= *Colletotrichum lagenarium*)

Colletotrichum orbiculare induce fruit rot. Spots on leaves are often large (diameter > 1 cm), round shaped, brown in color with a brighter centre. Margins are distinct. Spots crack when weather is dry and hot. Damages on fruit appear as depressed spots with a diameter of 2-3 cm. The spots are covered by redish dots when the weather is humid. Concentrics rings of conidia conidies (acervulus) might be noted.



Spots on cucumber leaf



Rot on cucumber fruit

Gummy stem blight – Black rot – Canker - *Didymella bryoniae* (*Cercopsora citrullina*)

In rainy season the cucumber is particularly sensible. This fungus induces a gummy stem blight and a black rot on fruit.



Spots on a leaf



Symptoms on a stem

Powdery Mildew

Erysiphe cichoracearum – *Sphaerotheca fuliginea*

Small whitish and powdery spots appear on both surfaces of leaves, on leaf stalks and green stems. The signs of an attack are first seen on older leaves, and later on younger ones. On melon and cucumber, the presence of the disease results in the appearance of small, isolated, round, pale green spots on the upper surface of the leaves, quickly followed by the development of the whitish down of the fungus. The spots converge; seriously infected leaves become twisted, turn yellow, necrotise and dry up. There are on average fewer than 7 days between the contamination and the appearance of symptoms.



Whitish spots on the underleaf of zucchini plant



Whitish spots on the upper face of a zucchini leaf

Downy mildew - *Pseudoperonospora cubensis*

Angular, yellow-green spots, 10-15 mm, confined by the leaf's veins (especially in cucumber) appear on the upper surface of leaves. On the lower surface of leaves, purplish grey or sometimes brown mould is visible. The spots converge; the affected tissues turn brown and necrotise and the leaves shrivel and dry. This pathogen can infect the cotyledons but not very young leaves, which will only be infected some 15 days after sprouting.

The disease often develops very quickly.

The zucchini seems to be less sensible than melon or cucumber.



Spots on a cucumber leaf

Stem and collar rot - *Pythium aphanidermatum*

The stem can be infected at the nodes in contact with the ground. The fungus causes soft rot followed by wilting of the stem.

Scab of cucurbits - *Cladosporium cucumerinum*

C. cucumerinum may infest any aerial part of the plant. On leaves, water-soaked and light-green spots with a diameter of 3-4 mm are the first symptoms. These spots often numerous may appear on or between the veins. Similar and elongated spots may be found on stems and leafstalks. Necrotizing spots become grey and shape turn from round to angular often with yellowish margins.

Dead tissues crack and fall giving to leaves a ragged aspect. When young plants are infected, stem and leaves rot readily.

This disease can induce heavy damages on fruits that eventually rot on cucumber and zucchini plants.

Spots become darker as they age and can induce a cavity in the fruit. A gummy substance, droplet shaped, exudes at the margin of the infected zone and particularly on pulpy fruits.



Symptoms on a cucumber fruit

BACTERIA

Bacterial disease - Angular leaf spot of cucumber - *Pseudomonas syringae* pv. *lachrymans*

Damage occurs mainly on leaves. Formation of angular spots confined by the veins. The interior of the spots subsequently necrotises and drops out, leaving a well-defined shot-hole. On fruit, the spots are small and spread in the form of soft rot. On zucchini foliar spots are surrounded by a yellow halo.



Damage on a cucumber leaf



Symptoms on a cucumber

VIRUSES

CMV (cucumber mosaic virus)

The plant first presents thinning-out of veins, sometimes with reddish necrotic areas on adult leaves. A pronounced "mosaic" then appears, in the form of mottled shapes of different sizes, dark and light green in colour, and foliage growth is stunted; leaves are blistered. The infected plants have slow growth. A dark green marbling against a light green background can be seen on fruit. The setting of flowers emerging after contamination is reduced. The infected plants have stunted growth, their growth habits are modified and fruit production declines. On young leaves, chlorotic spots appear, forming a more or less pronounced mosaic.



Symptoms on a cucumber leaf

ZYMV (zucchini yellow mosaic virus)

Damages on zucchini are very serious. A weak infestation lead to the appearance of a simple mosaic with no observable deformations. In case of higher infestation, colour of leaves turn to light green or yellow with some dark green area of various sizes. These area are often blistered. Area along the veins brighten. They can be deformed. In utmost case, leaves may have a stringy aspect (These symptoms must not be confused with those of a severe infestation by the broad mite, *Polyphagotarsonemus latus*). Infested fruits present dark green puffy area. Young plants are stunted with a reduced foliage. They will not produce fruits.



Yellowing of zucchini leaves



Stringy aspect of zucchini leaves



Blisters on zucchini

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.

Stade	Length of stage	Chrysomelidae	<i>Henosepilachna elaterii</i>	<i>Diaphania</i> spp.	Cucurbit flies	<i>Liriomyza trifolii</i>	<i>Bemisia tabaci</i>	Thrips	<i>Aphis gossypii</i>	<i>Tetranychus</i> sp.	Meloidogyne spp.	<i>Fusarium</i> sp.	Gummy stem blight - Anthracnose - Scab	<i>Erysiphe cichoracearum</i> <i>Sphaerotheca fuliginea</i>	<i>Pseudoperonospora cubensis</i>	<i>Pythium</i> sp.	<i>Pseudomonas syringae</i>	CMV and ZYMV
Seeds																		
From sowing to emergence	1 week																	
From emergence to flowering	7-8 weeks																	
From flowering to first harvest	1 - 2 weeks																	
From first harvest to peak of harvest	4 weeks																	
From peak to final harvest	4 weeks																	

■ Periods during which pests and pathogenic agents are potentially present.

■ Periods during which the appearance of large numbers of pests or a serious case of disease can cause the greatest loss.

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

Key:

KEN = Kenya, DOR = Dominican Republic, GAM = Gambia, SEN = Senegal, TAN = Tanzania, ZAM = Zambia

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.

African melon ladybird beetle - *Henosepilachna elaterii*

Favourable conditions: Generally more abundant in rainy season in the Sahel countries.

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
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
SEN	+	+	+	+	+	++	++	++	++	++	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	0	0	0	0	0	0	0	0	0	0	0	0

Webworm - *Diaphania* spp.

Favourable conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
GAM	X	X	X	X	X	X	X	X	X	X	X	X
SEN	+	+	+	+	+	0	0	0	0	0	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Fruit flies - *Dacus* spp., *Bactrocera* spp.

Favourable conditions: Fruit flies thrive with hot and humid weather. The optimal temperatures for the development are 26-30 °C. For additional information on presence of fruits flies in african countries please consult the web site <http://www.africamuseum.be/fruitfly/AfroAsia.htm>

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
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
SEN	+	++	+++	+++	+++	+++	+++	+++	+++	+++	++	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

American leafminer fly - *Liriomyza trifolii*

Favourable conditions: In the Sahel zone, this pest is more frequent in the dry season. In Kenya, infestation are heavy in warmer periods.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	++	++	+	+	+	+	+	+	+	+	+	++
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	X	X	X	X	X	X	X	X	X	X	X	X
SEN	+	++	++	++	++	+	0	0	0	0	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	0	0	++	++	++	++	++	++	++	++	++	++

White fly - *Bemisia tabaci*

Favourable conditions: High air humidity and high temperature (25-30 °C) favour infestations. Dry winds lower infestations. In Kenya, *Bemisia* is usually more important at the beginning of the dry season.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	+++	+++	+++	+	+	+	+	++	++	++	+	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	X	X	X	X	X	X	X	X	X	X	X	X
SEN	+	+	+	+	+	0	0	0	0	0	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Thrips - *Ceratothripoides cameroni* / *Frankliniella occidentalis* / *Thrips* spp.

Favourable conditions: Thrips infestation develop when weather is hot and dry. Population is usually in rainy season.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	+	++	+	+	+	+	0	+	+	+	+	++
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	+	+	+	+	+	++	+++	+++	+++	+++	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	++	++	++	++	++	++	++	++	++	++	++	++

Aphids - *Aphis gossypii*

Favourable conditions: *Aphis gossypii* can live in temperatures of up to 30°C and is especially frequent in the warm and dry season. At temperatures of over 30°C its activity is limited.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
SEN	+	++	++	++	++	++	0	0	0	0	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Red spider mite - *Tetranychus* sp.

Favourable conditions: Favoured by high temperatures (around 32°C) and dry weather. Prevalence rise in dry area. Heavy rain diminish the population of this pest. Wind is an important way of dissemination.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
SEN	+	+	++	++	++	++	0	0	0	0	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	0	0	0	0	0	0	0	0	+	++	++	++

Root-knot nematode - *Meloidogyne* spp.

Favourable conditions: Present throughout the year, but less so during the dry season in cool zones. Optimal temperatures are 26 – 28 °C.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
SEN	++	++	++	++	++	++	++	++	++	++	++	++
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Wilt or fusariosis - *Fusarium solani*, *Fusarium oxysporum* f. sp. *cucumerinum*

Favourable conditions: Temperatures of between 18 and 23°C and relatively high air humidity are favourable to the development of symptoms of the disease. At temperatures of over 30°C, contaminations are much less severe.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	+	++	+++	+++	0	0	0	0	0	0	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Powdery mildew - *Erysiphe cichoracearum*, *Sphaerotheca fuliginea*

Favourable conditions: Warm weather (24 to 30°C), no rain, with relative humidity between 50 and 90%.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	+	++	++	++	++	+	0	0	0	0	+	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	+	0	0	+	+	++	++	+++	+++	+++	++	++

Downy mildew - *Pseudoperonospora cubensis*

Favourable conditions: Cool (18-22°C) and humid weather (watering, dew). Daytime temperatures of 20 to 22°C and a night-time temperature of 15°C are favourable to the disease. It develops ideally during long cool nights with abundant dew.

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
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
SEN	+++	+++	+++	++	++	0	0	0	0	0	++	+++
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	/	/	/	/	/	/	/	/	/	/	/	/

Collar rot - *Pythium aphanidermatum*

Favourable conditions: Damp and heavy soils with difficult germination conditions.

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
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	0	0	+	++	0	0	0	++	++	+	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	++	++	++	0	0	0	0	0	0	0	0	0

Angular leaf spot - *Pseudomonas syringae* pv. *lachrymans*

Favourable conditions: Heavy rains and high humidity with long period of water presence on the leaves. Teeming rains with strong wind. Optimum temperatures are 24 - 28°C.

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
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	/	/	/	/	/	/	/	/	/	/	/	/
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	++	++	++	0	0	0	0	0	0	0	0	0

Mosaic disease CMV / ZYMV

Favourable conditions: More abundant in periods favourable to aphids.

Month	1	2	3	4	5	6	7	8	9	10	11	12
KEN	+++	+++	++	++	++	++	++	++	++	+++	+++	+++
DOR	/	/	/	/	/	/	/	/	/	/	/	/
GAM	/	/	/	/	/	/	/	/	/	/	/	/
SEN	+	++	++	++	++	++	0	0	0	0	0	+
TAN	/	/	/	/	/	/	/	/	/	/	/	/
ZAM	++	++	+++	+++	++	+	+	+	+	+	+	+

Minor diseases and pests				
	<i>Chrysomelidae</i>	Anthracnose <i>Colletotrichum orbiculare</i>	Gummy stem blight <i>Didymella bryoniae</i>	Scab of cucurbits <i>Cladosporium cucumerinum</i>
Favourable conditions	/	High humidity (irrigation, dew) and temperatures around 20° C	Heavy rains and high humidity with long period of water presence on the leaves. Optimal temperatures (20 to 28° C)	Heavy rains and high humidity with long period of water presence on the leaves. Optimal temperatures (18° C)
KEN	X	/	X	/
DOR	/	/	/	/
GAM	/	/	/	/
SEN	/	/	/	/
TAN	/	/	/	/
ZAM	/	+++ rainy season	+++ rainy season	+++ rainy season

2. Main control methods

2.1. Introduction

General points to control plant pests and diseases:

Chemical products are one way to control pests and diseases. They should be used along with other methods such as the choice of resistant varieties, growing methods, etc.

For example, tilling the soil after harvest helps destroy some of the pests whose development includes a stage in the ground (e.g. *Aulacophora* eggs, larvae and pupae; *Dacus* pupae; etc.).

The destruction of plants and crop residues eliminates certain pests remaining in or on the plant (e.g. *Aulacophora* larvae, *Henosepilachna* pupae, *Dacus* maggots and pupae, *Liriomyza*, white fly larvae, etc.).

In the case of PPP, for repeated applications to control pests with short life-cycles and closely spaced generations (aphids, whitefly, mites), it is important to alternate active substances with different modes of action, in order to limit the risks of resistance.

Selective products should be used wherever possible to limit the negative impact on auxiliary insects.

Similarly, in case of application during the flowering period, products respectful of pollenising insects should be chosen.

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.

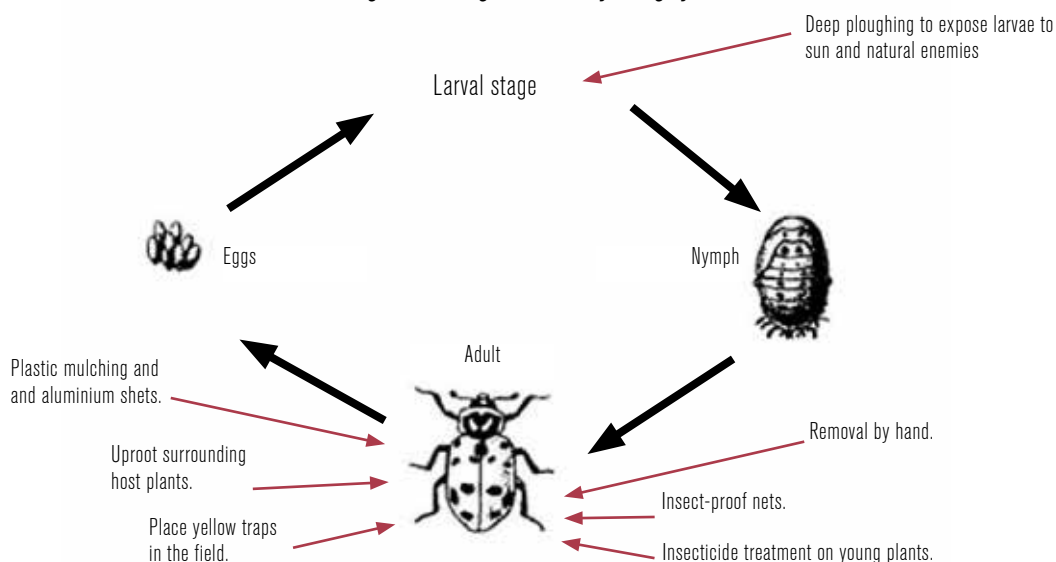
The third column shows the cultivation stage during which these actions should be taken.

LEAF-EATING BEETLES - *CHRYSOMELIDAE*

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

Watch young plants closely, since they are subject to attack by larvae and adults.

It is recommend to grow seedlings in a nursery in highly infected area.



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

Nursery

- Uproot all cucurbits and weeds neighbouring the nursery
- Use a physical protection (insects-proof nets ...) from emergence to young plant stage
- Removal of adults by hand.
- Insecticide treatment for serious outbreaks.

Field

During the production cycle, and particularly in the growth stage

- Uproot wild cucurbits which represent a source of infestation.
- Removal of adults by hand on small crops.
- Insecticide treatment on young plants in case of serious outbreak.

After the final harvest

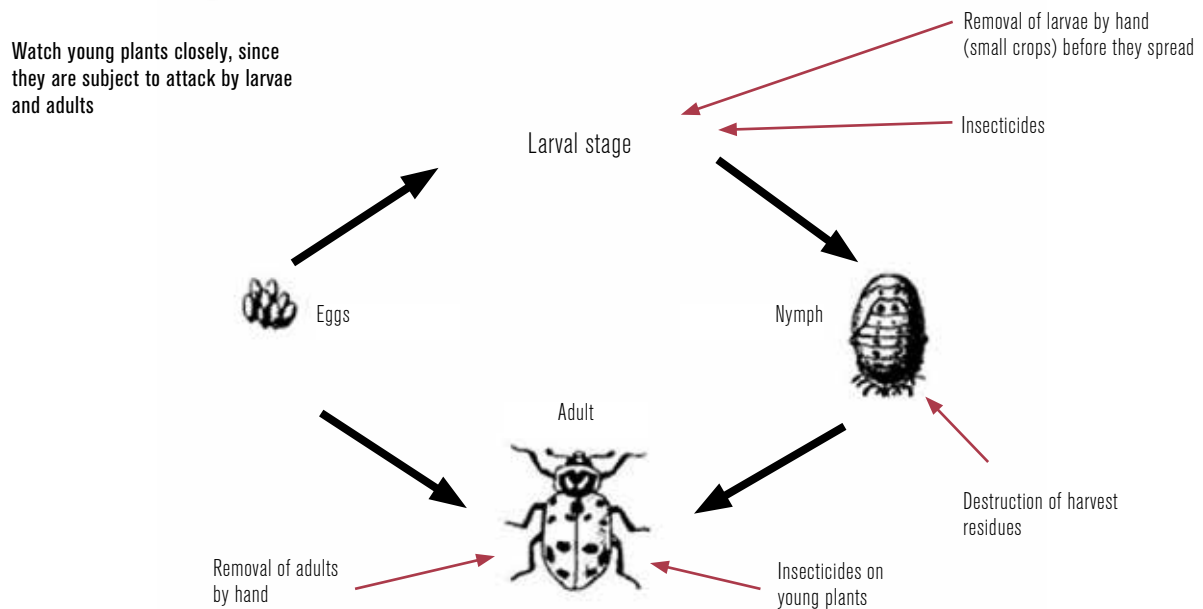
- Bury deeply crop residues. Larvae will not survive.

Validity and relevance to be checked in local conditions:

- Plant on balk to drain quickly the soil.
- Keeping the soil dry can help eliminate eggs through desiccation.
- Hand picking of adults to reduce the population. Since *chrysomelidae* prefers the shade one must inspect the underleaf and the base of plants.
- Put yellow traps in the field.
- Furrow irrigation: the soil at the base of the plant remains dry, which is unfavourable to the development of the pest.
- Plastic mulching and aluminium sheets. Reflet holds off adults.

AFRICAN MELON LADYBIRD BEETLE (*HENOSEPILOCHNA ELATERII*)

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

- Removal of larvae and adults by hand.
- Insecticide treatment in case of serious outbreak.

Field

During the production cycle, and particularly in the growth stage

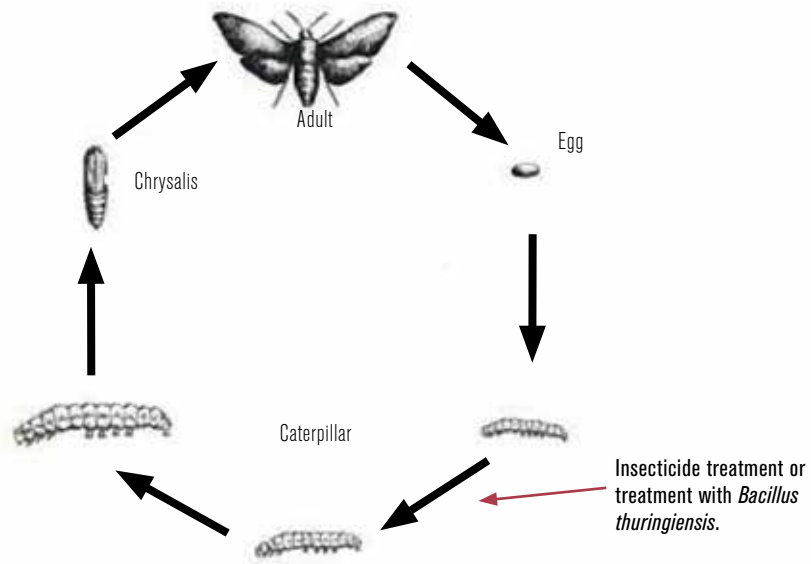
- Removal of larvae and adults by hand (small crops).
- Insecticide on young plants in case of serious outbreak.

After the final harvest

- Destruction of harvest residues.

WEBWORM (*DIAPHANIA SPP.*)

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

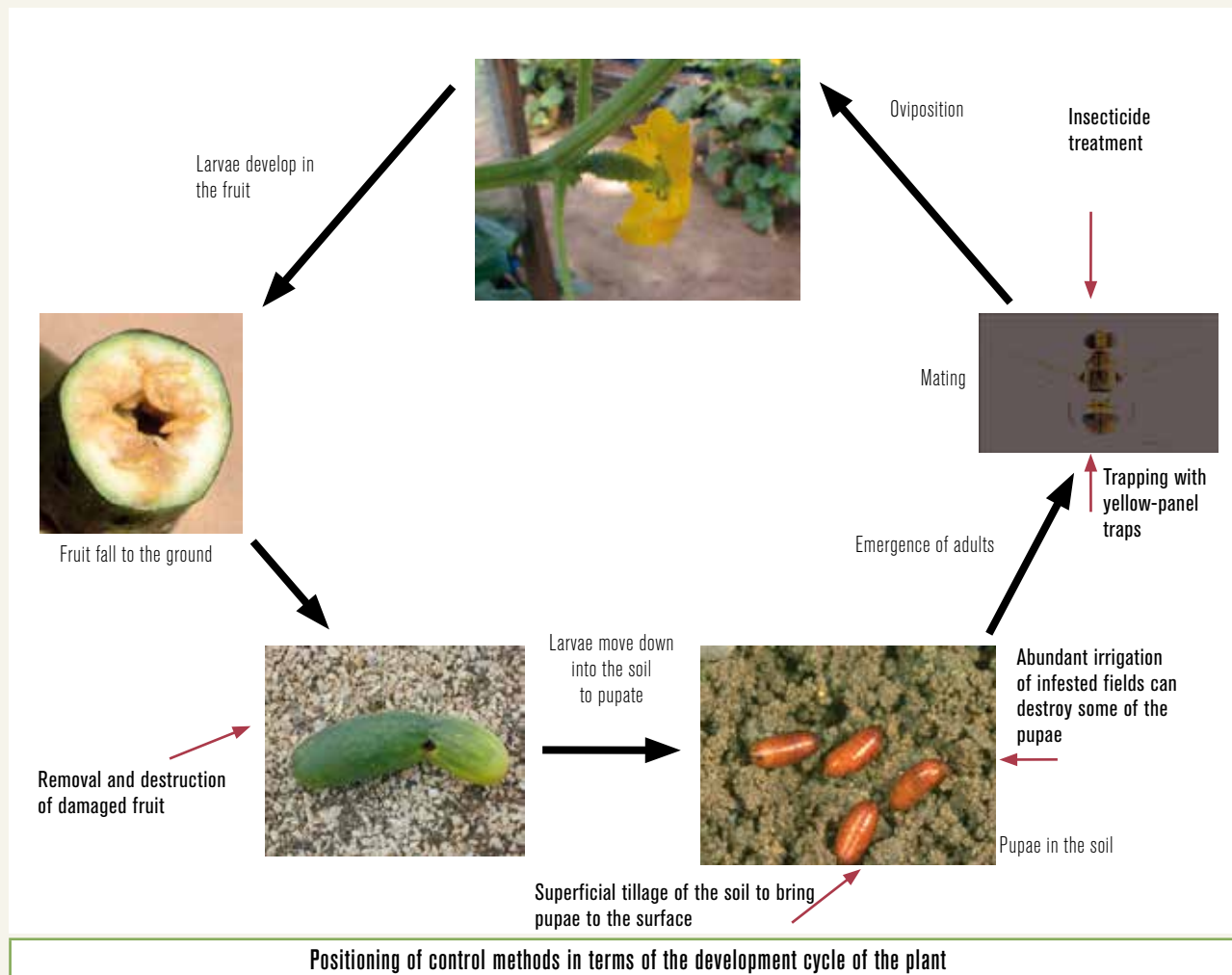
Field

During the development cycle

- Keeping close watch over young plants allows early detection of attacks, which generally require a single application of insecticide, only in the case of heavy infestation.

FRUIT FLY (*DACUS* SPP., *BACTROCERA* SPP.)

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

Field

Throughout the production cycle

- Destruction of nearby wild cucurbits which can be important reservoirs of infestation.

From the first settings

- Trapping with yellow sticky panels placed on the plot to monitor evolution and reduce the population of adult flies.
- Insecticide treatment.

From the first harvest

- Removal and destruction of damaged fruit through crushing and deep burial (60-90 cm) or burning.

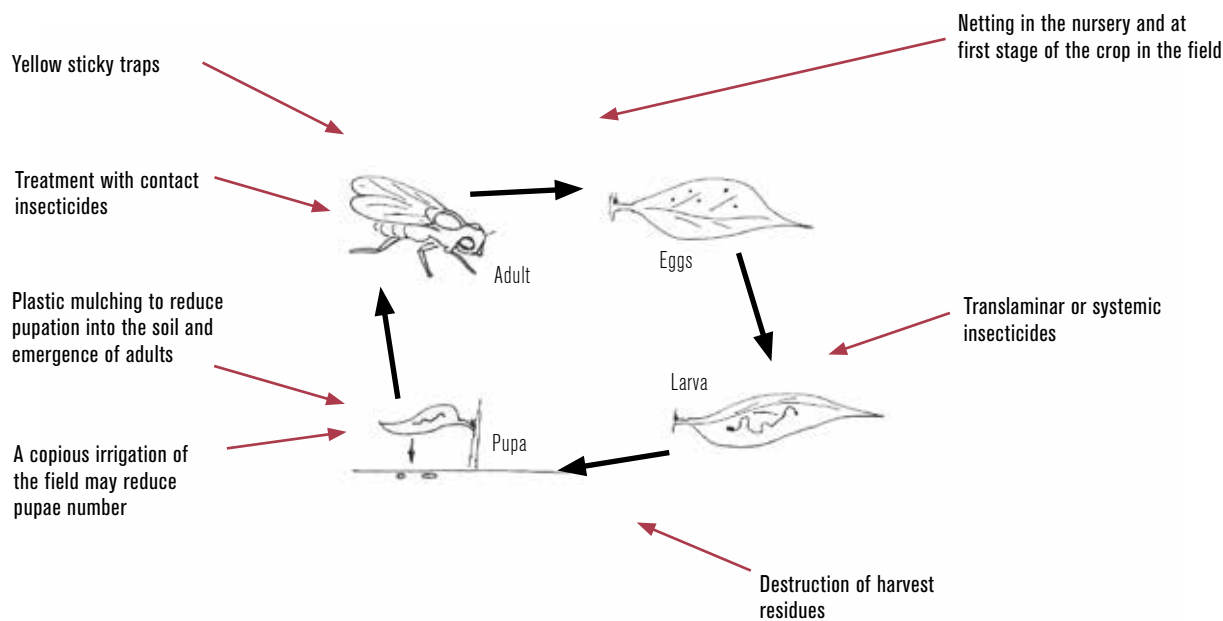
After the final harvest

- Use of lime during burial to kill emerging larvae.
- Abundant irrigation of infested fields can destroy some of the pupae.
- Superficial tillage of the soil can bring the pupae to the surface and expose them to predators, parasites and sunshine.

AMERICAN LEAFMINER FLY (*LIRIOMYZA* SP.)

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

It is imperative to protect auxiliaries.
Broad-spectrum insecticides and repeated applications should be banned.



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

Nursery

- Cover with a net to avoid arrival of adults on the plants and oviposition.
- Treatment with selective (to protect natural enemies), contact (to control the adults), translaminar or systemic insecticides (to kill larvae) used alternately (to limit risks of resistance) in case of serious outbreak.

Field

At field setting

- Cover the crop at early stages with a net to avoid arrival of adults on the plants and oviposition.
- Choose a field isolated from other crops sensible to leafminers.
- Flood the field to destroy the pupae in the soil.
- Provide a plastic mulching to reduce pupation into the soil and emergence of adults.

During the production cycle

- Treatment with selective (to protect auxiliaries), contact (to control the adults), translaminar or systemic insecticides (to kill larvae) used alternately (to limit risks of resistance) in case of serious outbreak.
- Use yellow sticky traps to reduce adults population.

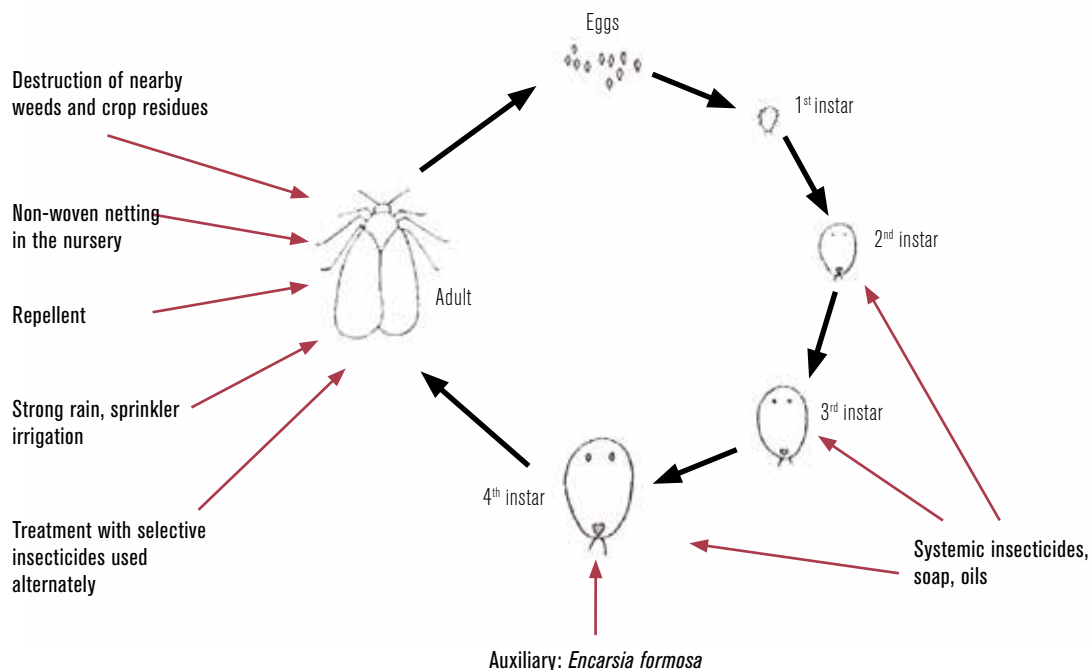
After the final harvest

- Destruction of harvest residues.

WHITE FLY (*BEMISIA* SP.)

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

The use of broad-spectrum insecticides could be harmful to auxiliaries.
Low air humidity and temperature (< 16°C) help reduce the level of infestation.



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

Nursery

- Control of weeds (host plants for whitefly) to limit sources of infestation.
- Protective netting.
- Auxiliary: *Encarsia formosa* (in greenhouse).

Field

During the production cycle

- Control of weeds (host plants for whitefly) to limit sources of infestation.
- Sprinkler irrigation or strong rain will limit the spread of the pest.
- Systemic insecticides to control the pupae (puparium), soap, oils.
- Selective insecticides (to limit the negative impact on auxiliaries) used alternately (to limit the risks of resistance) to control adults.
- Auxiliary: *Encarsia formosa* (in greenhouse).

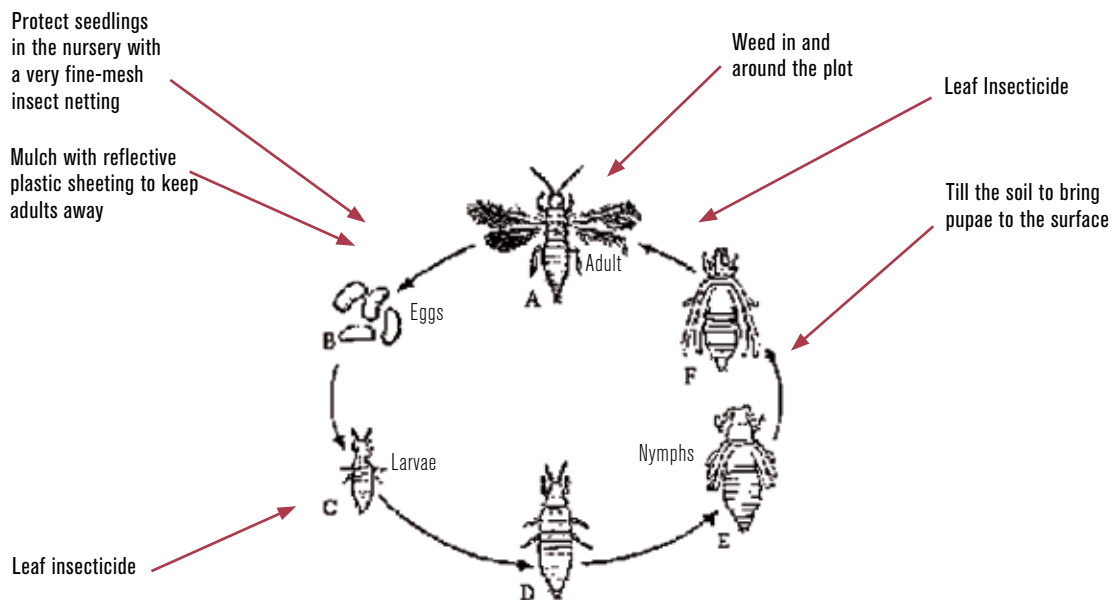
After the final harvest

- Destruction of harvest residues.

THRIPS

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

Avoid repeated use of broad spectrum insecticides, which are harmful to auxiliaries. Practise good crop rotation to reduce the pest population significantly. Stagger the sowing period to avoid the main infestation period (rainy season for *C. cameroni*)



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

Nursery

- Protect seedlings with insect netting, because young plants are sensitive to attacks by thrips.

Field

During the production cycle

- Leaf insecticide as needed.

After the final harvest

Till the soil to bring the pupae to the surface; they will be killed by the heat of the sun or by natural enemies.

Validity and relevance to be checked in local conditions:

- Mulch with reflective plastic sheeting. The reflection keeps insects from spotting the plant until it covers 60% of the soil. At that stage, the mulch is no longer effective, but the plant can control infestations of viral disease.
- Mulching with organic matter could also be effective to prevent thrips from attacking cucurbits crops.
- Weed in and around the plot.

MELON APHID (*APHIS GOSSYPII*)

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

Regular inspection of the plants is needed to detect the appearance of the pest. To reduce the impact of insecticide treatments on auxiliary insects (ladybirds, syrphus flies), specific insecticides should be chosen.

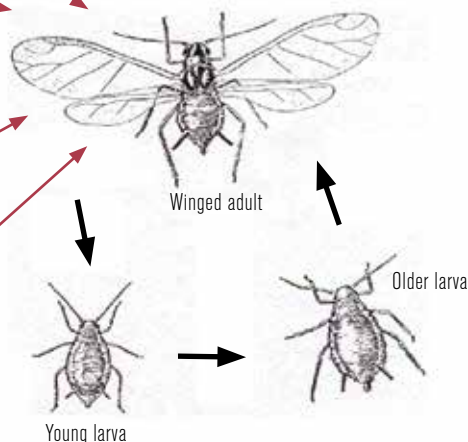
Insect netting on young seedlings (nursery)

Use sticky or water yellow-panel traps in the plot

Repellent plants to hold off the adults from the field

Uproot of host plants neighbouring the field

A reflective ground covering can slow infestation when the plants are still small



To control all stages

- Natural heavens to encourage natural enemies e.g. beetles and hoverflies, *Aphidius*
- Use of selective insecticides: soap solutions, neem products
- Sprinkler irrigation, strong rain
- Natural enemies: Parasitic wasps, predators (ladybird beetles, hoverflies, lacewings)
- Control ants in the field, as these will disrupt natural enemy activities

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

Nursery

- Young plants in the nursery are vulnerable to attacks by aphids. The elimination of spontaneous cucurbits and weeds around the nursery is advisable.
- Treatment with selective insecticides as soon as attacks have been detected on young plants.

Field

- Sprinkler irrigation or sustained rain can reduce infestation.
- Use well-balanced fertilisation, because an excess of nitrogen predisposes the plants to attacks by aphids.

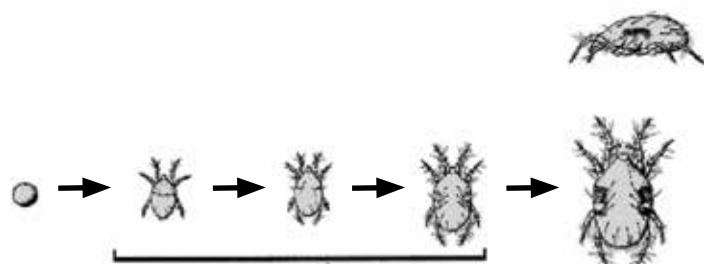
During the production cycle

- Install yellow traps in the plot to monitor the population level and to reduce infestation somewhat; it is imperative to detect attacks at the earliest stage of cultivation to limit the risks of early transmission of viruses (CMV, etc.) or direct damage by large populations of aphids.
- Treatment with a selective insecticide upon detection of attacks on young plants.
- Destroy plants heavily infested.
- Certain plants are said to keep aphids away (big marigolds, etc.); they can be planted near the crops.
- Reflecting mulch can reduce infestation at early stages of the plants.

RED SPIDER MITE (*TETRANYCHUS SP.*)

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

Control has to begin in the nursery as soon as the pest is detected. Careful inspection of the underside of leaves is the best way of detecting an infestation from the beginning. In case of repeated applications, it is recommended to alternate active substances with different mode of action to prevent the appearance of resistance.



Plant hedges around field to reduce dust build up and migration of adults between fields

To control all stages

- Encourage and release natural enemies such as predatory mites
- Apply specific acaricides to control larva, nymph and adult (some are also ovicide)
- Apply products such as starch, milk and oil to suppress mite populations
- Dowse dirt track with water
- Apply overhead irrigation to increase microclimate humidity
- Remove and destroy trash from field, after harvest, immediately to avoid build up of populations in the field

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

Nursery

- A monitoring of the underleaf is useful to detect early infestation. If necessary, apply products that will eradicate the pest so that plants will be healthy upon leaving the nursery.

Field

At field preparation

- Where practical, hedges can be planted around the field to help reduce dust reaching the crop.

Throughout the production cycle

- Red spider mites thrive in dry conditions. Applying overhead irrigation on a regular basis will increase the microclimate humidity. This will lead to an unfavourable environment for mite development. The application of overhead also washes off a significant number of mites.
- Dust from farm tracks can get blown onto the webbing created by mites, further protecting them from pesticide control. In addition the photosynthetic capability of the plant is reduced. Any road close to the crop should be dowsed in water on a regular basis to reduce dust.
- Weeding around the field during the crop cycle is advisable as the mite on these plants will move into the crop.
- Predatory mites, such as *Phytoseiulus persimilis* can be used to suppress populations.
- Products such as starch, milk and oil can be used as sprays to help suppress mite populations.
- Apply miticides during early development of populations, before webbing formation.

After last harvesting

- Remove and destroy trash from field, after harvest, immediately to avoid build up of populations in the field.
- Removal of the weeds once the crop is removed will help suppress mites moving to alternative hosts.

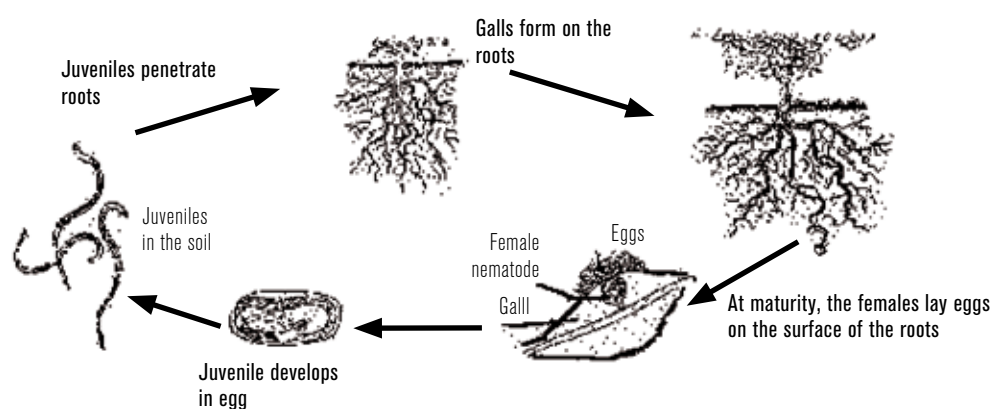
ROOT KNOT NEMATODE (*MELOIDOGYNE* SPP.)

Natural factors favourable to the pest:

- Significant presence in sandy, light soils without excessive water.
- In the young larval stage, the nematode is an aquatic animal that moves in water in the ground. Nematodes therefore spread more easily in damp and light soils.

Major elements of the control strategy:

- Apart from the use of tolerant or resistant varieties, cultivation practices and field hygiene are the best ways of limiting damage from nematodes.
- Light soils should be avoided. Clayey soils are preferable, in particular vertisol soils.



Development cycle of root-knot nematode

Actions that can be used to control the pest are shown in the following table.

Development stages of the pest	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Mobile phase in the ground	Disinfection of the substratum or the soil (solarisation, heat treatment).	X				X					
	Prolonged flooding of the ground results in a significant reduction of infestation by killing larvae and adults.				X	X					
	The addition of organic matter (thoroughly decomposed compost, plant slurry) has a depressive effect on nematodes. The decomposed organic matter activates certain soil fungi, which capture the nematodes.				X	X					
	The planting of marigolds and crotalaria intercropped throughout the plot can reduce the infestation rates as a result of their nematicide action.					X	X				
Penetration and development in the plant	Localised treatment of the soil in the field (planting hole, strip) with a nematicide can prove necessary in severely infested ground.					X	X	X			
Conservation in the ground	Working shrimp compost into the ground can limit the impact of the infestation.					X					
Transport through water or displaced soil	Transferring soil from an infested area should be avoided.					X	X				
	The disinfection of work tools limits the contamination of the ground by soiled material.					X	X				
Multiplication on another crop or on weeds	The use of adequate rotation, avoidance of the use of plots where crops sensitive to nematodes have been grown (tomato, okra, etc.) and the introduction into crop rotation of less sensitive vegetable species (onions, sweet potato, etc.) help limit the extent of damage caused by nematodes.				X	X					
	The use of plants that trap nematodes (groundnut) in crop rotation limits infestations. Likewise, intercropping with grasses can help reduce the level of infestation.				X	X					

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

FUSARIOSIS (*FUSARIUM* SP.)

Natural factors favourable to the fungus:

- Humid soil, high level of organic matter.

Major elements of the control strategy:

- The pathogen is conserved in the ground in the saprophyte state, colonising plant debris.
- Cultivation methods alone, such as the use of long rotation periods (3 to 4, or even 8 years) with crops other than cucurbits, can reduce the impact of the disease.
- The use of resistant varieties and of healthy seeds is strongly recommended.
- Use plants grafted onto resistant rootstock.
- Fungicide treatments are generally ineffective.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Raising and maintaining the soil pH to 6.0 – 7.0 by liming helps limit the disease.				X	X					
	The plant stems need to be kept free of attack from insects whose bites represent places of entry for fungi and bacteria.	X		X				X			
	The growing of cucurbits on plots where water stagnates, in overly damp or very heavy soil should be avoided, to help keep the plant collar dry.				X	X					
	Use plants grafted onto resistant rootstock.	X	X	X			X				
Development in the plant	Excessive nitrogen fertilising is to be avoided. Sufficient application of calcium and potassium seems to reduce attacks.					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	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 water or displaced soil	Caution is needed to keep from contaminating disinfected plots with agricultural material or contaminated soil.					X	X				
	The disinfection of tools (bleach) limits the propagation of the disease.			X		X	X				
Multiplication on another crop or on weeds	Use of long rotation periods (3 to 4 years).				X	X					

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

GUMMY STEM BLIGHT (*DIDYMELLA BRYONIAE*)

Major elements of the control strategy:

- A long rotation (at least 2 years) with non cucurbit crops.
- Good sanitation in the field is the best preventive control. Conditions conducive to the pathogen development should be avoided.
- An accurate monitoring of leaves is necessary to detect beginning of the infestation and start sprayings on time.
- Avoid building of high humidity in the field.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Seeds should be healthy and disinfected		X								
	Use of variety resistant to <i>Oidium</i> limit infection by <i>Dydymella</i> .		X								
	Disinfect soils and destroy infected plants.	X									
	Select a piece of land exposed to the sun all the day round and a well drained soil.				X	X					
	Plant in lines parallel to prevailing winds to favour air movement, avoid shades of windbreaks.				X	X	X				
	Observe intervals of planting, avoid high density.					X	X				
	Avoid water on foliage during irrigation ; bring water at the base of young plants ; avoid sprinkler irrigation or do them early in the morning to assure drying of water on leaves ; in case of dew during dry season, sprinkler irrigation should be done after evaporation of the dew.					X	X	X	X		
	When climate conditions are favourable to the fungus, spraying of fungicides should be done in the few hours following a sprinkler irrigation and taking care to cover also the under leaf.			X				X	X		
Development in the plant	Fungicides application as described above.			X				X	X		
Production of spores	Destroy all plants after last harvest.								X	X	
Dissemination of spores	Avoid walking through the plots when the plants are wet.							X	X		

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Dissemination of spores	Control aphids and beetles to reduce spreading of the disease.							X	X		
	The disinfection of tools (bleach) limits the propagation of the disease.							X	X		
	Mulching reduce splashing of water that are a way of the disease spreading.							X	X		
	When the disease break out, sprinkler irrigation should be avoided to reduce spores dissemination.							X	X		
Multiplication on another crop or on weeds	Clean up the area surrounding the nursery and field (the fungus spores survive on wild cucurbits).						X	X	X	X	

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

ANTHRACNOSE (*COLLETOTRICUM ORBICULARE*)

Major elements of the control strategy:

- Use resistant varieties.
- Use healthy seeds, certified and treated (Thiram, captan).
- Respect a rotation (2 to 3 years) with crops other than cucurbits, tobacco, peppers and tomato.
- Plant on balks to avoid contamination through streaming water after a rain.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Disinfect soil and destroy infected plants.	X									
	Select a piece of land exposed to the sun all the day round and a well drained soil.				X	X					
	Plant in lines parallel to prevailing winds to favour air movement, avoid shades of windbreaks.				X	X	X				
	Observe intervals of planting, avoid high density.					X	X				
	Avoid water on foliage during irrigation : bring water at the base of young plants ; avoid sprinkler irrigation or do them early in the morning to assure drying of water on leaves ; in case of dew during dry season, sprinkler irrigation should be done after evaporation of the dew.						X	X	X	X	
	Lift up stems before they touch the soil. Avoid contact of fruits with the soil.									X	X
	When climate conditions are favourable to the fungus, spraying of fungicides should be done in the few hours following a sprinkler irrigation and taking care to cover also the under leaf.				X				X	X	
Development in the plant	Fungicides application as described above.			X				X	X		
	Pull out infected leaves and destroy them outside the field.			X				X			
	Strengthen young plants with manure can reduce impact of the disease.	X									

Development stage of the fungus	Action	Cultivation stages										
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest	
Production of spores	Destroy all plants after last harvest.										X	X
Dissemination of spores	Avoid walking through the plots when the plants are wet.								X	X		
	Control insects as some may carry the fungus.								X	X		
	The disinfection of tools (bleach) limits the propagation of the disease.								X	X		
	Mulching reduce splashing of water that are a way of the disease spreading.								X	X		
	When the disease break out, sprinkler irrigation should be avoided to reduce spores dissemination.								X	X		
Multiplication on another crop or on weeds	Clean up the area surrounding the nursery and field (the fungus spores survive on wild cucurbits).							X	X	X	X	

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

POWDERY MILDEW (*ERYSIPHE CICHORACEARUM*, *SPHAEROTHECA FULIGINEA*)

Natural factors favourable to the fungus:

- Plant sensitivity increases with age.

Major elements of the control strategy:

- Close monitoring of the crop when conditions are favourable for development of the disease. The use of tolerant varieties is recommended when these exist.
- The elimination of plant debris at the end of a growing season.
- Use resistant or tolerant varieties.
- Promote a vigorous growing but without excess on nitrogen.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Fungicide treatments are applied, 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	X		
Development in the plant								X	X		
Production of spores	Harvest residues must be removed and destroyed.								X	X	X
Spores carried by the wind	Avoid sowing near an older crop affected by powdery mildew.	X			X						
Multiplication on another crop or on weeds	Clean up the area surrounding the plot to limit contagion, because the fungus spores survive on wild cucurbits and other plants.	X				X	X	X	X	X	

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

DOWNY MILDEW (*PSEUDOPENOROSPORA CUBENSIS*)

Major elements of the control strategy:

- Use of resistant varieties when these exist.
- Good hygiene in the field is the best preventive measure. It will be done in order to discourage the creation of ideal conditions for the fungus.
- Careful inspection of leaves allows detection of an infestation from the start and intervention as soon as symptoms appear.
- Be careful not to keep the crop too damp.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Choose a plot exposed to sunlight all day long and with well-drained soil.				X	X					
	Plant rows parallel to the direction of the dominant winds to encourage the circulation of air and to avoid the shade of windbreaks.				X	X	X				
	Respect planting distances and avoid overly dense planting.					X	X				
	Avoid wetting leaves during irrigation; water around the base of young plants; avoid sprinkler irrigation or use it early in the morning to give leaves time to dry; in dry season when dew is present, sprinkler watering should not be used until the dew has evaporated.						X	X	X	X	X
	For intensive cultivation in climate conditions favourable to the disease, fungicide treatments should be used. Be sure to cover the underside of leaves completely; treatments should be applied within a few hours following sprinkler irrigation.			X					X	X	X
Development in the plant	Fungicide treatments, as described above.			X					X	X	X
Production of spores	Destroy foliage and debris from affected plots after the final harvest.									X	X
Dissemination of spores	Avoid to plant in the vicinity of cucurbit crops.							X	X	X	
	Avoid walking through the plots when the plants are wet.				X						
Multiplication on another crop or on weeds	Clean up the area surrounding the nursery and field (the fungus spores survive on wild cucurbits).						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).

STEM AND COLLAR ROT (*PYTHIUM APHANIDERMATUM*)

Major elements of the control strategy:

- Only proper hygiene in the field and appropriate cultivation methods can lessen the impact of the disease. Encourage vigorous growth.

Development stage of the fungus	Action	Cultivation stages										
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest	
Germination on the plant	Use treated seed for the protection of seedlings from the start.		X									
	Avoid damp plots and excessive watering; encourage good drainage.			X	X	X	X	X				
	Plant on mounds to facilitate the elimination of excess water.				X	X						
	Avoid excessive dampness of soil at night.			X			X	X				
Development in the plant	Apply specific and systemic fungicides by watering around the base of the plant (possibly using a drip irrigation system).						X	X				
Production of spores	Pull up and burn diseased plants.							X	X	X	X	
Conservation in the soil	Deep tillage is necessary to bury the harvest residues so that they decompose completely.					X						X
Spores carried by water	Avoid irrigating with water from infected plots.					X	X	X				
	Avoid transferring soil from infected plots.					X	X	X				
Multiplication on another crop or on weeds	Rotation is advised but is not very effective because the fungus remains in the soil as a saprophyte, living on plant debris.				X	X						

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

SCAB OF CUCURBITS (*CLADOSPORIUM CUCUMERINUM*)

Major elements of the control strategy:

- Respect a rotation (2 to 3 years) with crops other than cucurbits.
- Good hygiene in the field is the best preventive measure. It will be done in order to discourage the creation of ideal conditions for the fungus.
- Be careful not to keep the crop too damp.
- Avoid improperly drained soils.

Development stage of the fungus	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Seeds should be healthy and disinfected.		X								
	Use resistant varieties.		X								
	Choose a plot exposed to sunlight all day long and with well-drained soil.				X	X					
	Plant rows parallel to the direction of the dominant winds to encourage the circulation of air and to avoid the shade of windbreaks.				X	X	X				
	Respect planting distances and avoid overly dense planting.					X	X				
	Avoid wetting leaves during irrigation; water around the base of young plants; avoid sprinkler irrigation or use it early in the morning to give leaves time to dry; in dry season when dew is present, sprinkler watering should not be used until the dew has evaporated.						X	X	X	X	
	For intensive cultivation in climate conditions favourable to the disease, fungicide treatments should be used. Be sure to cover the underside of leaves completely; treatments should be applied within a few hours following sprinkler irrigation.				X				X	X	
Development in the plant	Fungicide treatments, as described above.			X					X	X	
Production of spores	Destroy foliage and debris from affected plots after the final harvest.								X	X	X
Dissemination of spores	Avoid walking through the plots when the plants are wet.								X	X	
Multiplication on another crop or on weeds	Clean up the area surrounding the nursery and field (the fungus spores survive on wild cucurbits).								X	X	X

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

ANGULAR LEAF SPOT (*PSEUDOMONAS SYRINGAE* PV. *LACHRYMANS*)

Major elements of the control strategy:

- Rotation every three to four years, because the bacteria survive in the soil.
- Use resistant varieties when these exist.
- Use healthy seeds.
- Avoid the prolonged presence of water on leaves.

Development stage of the bacteria	Action	Cultivation stages									
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest
Germination on the plant	Avoid excessively damp ground and excessive watering; encourage good drainage.				X	X		X	X		
	It is preferable to use drip irrigation.				X	X					
	Avoid excessive dampness of leaves at night.							X	X	X	
	Apply copper-based products as soon as attacks are detected.							X	X		
Dissemination	Destroy infected plants and crop residues.							X	X	X	X
Conservation in the soil	Use rotation every 3 to 4 years because the bacteria survive in the soil.				X						
Transported through water or displaced soil	For irrigation, avoid using surface water near neighbouring cucurbits crops.			X	X	X	X	X	X		
	Avoid transferring soil from infected plots.					X	X	X	X		
	Disinfect tools.	X		X		X	X	X	X		
Multiplication on another crop or on weeds	Use rotation every 3 to 4 years without cucurbits.				X	X					

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

CUCUMBER MOSAIC (CMV AND ZYMV)

Major elements of the control strategy:

- Because viral diseases are transmitted primarily by insects (aphids), it is important to control the vectors of viruses (see controlling aphids) on young plants.
- The use of tolerant varieties (when these exist) is recommended.
- CMV and ZYMV are capable of surviving on a large number of cultivated or wild host plants, and in particular on many commercial vegetable crops.

Stage of the disease cycle and/or vector to be controlled	Action	Cultivation stages										
		Preparation of substrate and nursery environment	Sowing	Nursery	Choice of parcel	Preparation of parcel	Planting	From planting to first harvest	From first harvest to peak of harvest	From peak to final harvest	After final harvest	
Inoculation in the plant	Avoid the presence of vectors by protecting the crop with non-woven netting until flowering.	X		X				X				
	Watch for the appearance of aphids (vectors) and control them until the fruit has formed, during the first stages of growth.			X					X			
Development in the plant	Use all means to speed up development of the young plant (watering, manure, etc.) and to get it through the sensitive stage as quickly as possible.							X	X			
Absorption by a vector	Destroy infected plants and crop residues.								X	X	X	X
Displacement of the vector of the virus	The planting of dense rows of maize, every 3 to 5 m, is said to slow the propagation of the virus. The maize is sown before the cucurbits so that it will have grown to at least 50 cm when the crop is planted.				X	X	X	X	X			
	Mulching the soil with plastic sheeting limits aphid infestation.					X	X	X				
Multiplication on another crop or on weeds	It is advisable not to plant cucurbits near crops already infected with this viral disease. Weed the area surrounding the field properly.				X	X	X	X	X			

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

2.3. Resistant or tolerant varieties

Cucumber

Suppliers	Varieties	Resistance or tolerance					
		Nematodes	Bacteria	Downy mildew	Anthracnosis	Powdery mildew	Virus
Grainetier Baumaux (France)	F1 Slice King	X	X	X		X	
	F1 Jazzer			X		X	
	F1 Burpless tasty green			X		X	
	F1 Matsuri			X		X	
	F1 Loustik					X	X
Vilmorin (France)	Jokey F1, Kybele F1, Spark F1			X		X	
	Murat F1			X		X	X
	Basil F1					X	
	Gynial F1						X
	Breso F1					X	X
Heirloom Vegetable Seeds (USA)	Straight 9			X		X	
	Marketmore			X		X	X
	Poinsett 76		X	X		X	
Technisem (France)	F1 Antilla			X	X	X	
	F1 Arizona		X	X		X	
	F1 Calypso			X	X		
	F1 Gemini 7			X	X		X
	Poinsett			X		X	
	F1 Olympic			X		X	X
	F1 Basma			X		X	X

Zucchini

Suppliers	Varieties	Resistance or tolerance	
		Powdery mildew	Virus
Baumaux (France)	F1 Cigal	X	X
	F1 Tiger Cross		X
Vilmorin (France)	Anissa F1		X
Seminis Vegetable Seeds (USA)	Fancyrook, Daisey F1, Sunray Hybrid	X	
	Sungreen F1, Conqueror III F1, Justice III F1		X
Tézier Seed	Prestige F1, Tosca F1	X	
Harris Moran (USA)	Royal Ace F1, Tlaloc F1, Signature F1, Moctezuma	X	
	Tigress, Powergrey, Jaguar , Puma		X
Novartis Seeds (USA)	Sunglo Hybrid	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.

Aphis gossypii

Natural enemies such as some ladybirds, lacewings and larvae of *Syrphidae* eat aphids. Some small wasps lay eggs in larvae of aphids. Then the larva grow inside the living aphid until the aphid die and become a brown/golden « mummy ». Moulds may also infect aphids reducing the population of the pest.

Bemisia tabaci

Lacewings and larvae of ladybirds eat nymphs and eggs of white flies. Small wasps parasite the nymphs. Specific molds may infect also the white flies.

***Diaphania* spp.**

Parasitoids:

- *Apanteles taragamae*: on larva (India)
- *Argyrophylax proclinata*: on larva
- *Chelonus*: eggs (Salomon Island)
- *Elasmus brevicornis*: on larva (India)
- *Eurytoma braconidis*: on larva, chrysalis (Tropical Africa)
- *Phanerotoma hendecasisella*: on larva (India)
- *Trathala flavo-orbitalis*: on larva (India)
- *Trichogramma chilonis*: eggs
- *Trichogramma confusum*: eggs (China)

Pathogenes:

- *Bacillus thuringiensis*: on larva

Liriomyza trifolii

Damages of leaf miners are sorely reduced by several parasitoids. It is recommended to not use large spectrum insecticides to prevent these natural enemies.

***Thrips* sp.**

Most of conventional insecticides seem to stimulate thrips population, probably by elimination of predators of the pest. Large spectrum insecticides should be avoided. In preference use selective insecticides to conserve natural enemies such as *Orius* spp.

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

Growers should identify 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 count pests and auxiliaries at least twice a week. Certain information is given below on the thresholds whose validity and relevance are to be checked in local conditions.

White fly (*Bemisia tabaci*)

Adults are generally monitored by using sticky yellow traps or by carefully turning over leaves to examine the underside, where whiteflies habitually feed and lay eggs. It is better to do so during the coolest part of the day when the whiteflies are less active. Whiteflies prefer younger leaves to older ones, but any fully-formed leaf on the younger third of lateral growth or the main stem can be used for the inspection. The biggest pupae are usually found on older leaves. There is no established threshold for whitefly on most cucurbits. In the USA, a threshold of three adults on the third youngest leaf has been used successfully for cantaloupe.

Thrips (*Thrips* sp.)

Wherever thrips are present, leaves and branches need to be examined. The branches have to be shaken vigorously against the inner side of a cardboard box and then the box checked for the presence of thrips. A magnifying glass can be useful for examining leaves. In the USA, an insecticide is applied if eight thrips are found per leaf or if 20% of branches are infested.

Webworm (*Diaphania* spp.)

Careful monitoring is needed to detect *Diaphania indica* larvae as soon as they start to feed. Regular checks should be made on harvests twice a week to detect larval populations. Inspections should include the underside of leaves, soft stems and surfaces where the fruit is in contact with the ground.

Aphids (*Aphis gossypii*)

Aphids are generally gregarious and are sometimes found on only a few leaves. The aphid population can rise very quickly, and this aspect must be kept in mind when watching out for this pest. The plants must be checked at least twice a week, with particular attention given to the underside of leaves. Most problems occur towards the end of the growing stage. Puckered, thickened and crumpled leaves is a good indication of the presence of aphids. The underside of the leaves should be inspected. If an average of more than five to 10 aphids per leaf is found on 20 to 50 leaves at different places in the field, measures should be taken.

Leaf-eating beetles (*Acalymma vittatum* , *Diabrotica undecimpunctata*)

Damage to young plants can be serious, so plants must be inspected regularly starting from emergence or transplanting.

- Edges of the field should be specifically monitored. If plants are severely attacked or if 5 leaves with damages per plant an intervention is necessary.
- Monitor young plants twice a week, especially when they have less than 5 leaves (sensible stage).
- Since *Chrysomelidae* prefer to stay in shaded sites, one must observe the underleaf and the base of the plant. Monitor on 5 plants per balk. The threshold is 1 adult per plant.

Red spider mite (*Tetranychus urticae*)

The crop must be inspected at least twice a week using a magnifying glass and checking the underside of leaves in particular, because the presence of spider mites is not always visible on the upper side.

Angular leaf spot (*Pseudomonas*)

Water-soaked lesions on leaves caused by *Pseudomonas syringae* pv. *lachrymans* can be confused with mildew lesions caused by *Pseudoperonospora cubensis* in the field. However, a specific symptom of angular leaf spot is the presence of exudation secreted from the lesions.

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 or biocontrol agents is suggested for each pest or disease. When available, the critical GAP is also given.

The PHI (Pre-Harvest Intervals) are also indicated for:

- either to comply to the European MRL (for foodstuffs exported to EU)
- or to comply to the Codex MRL (for foodstuffs marketed in countries which refer to the Codex MRLs)
- or to produce without quantifiable residues and so respond to « 0 » residues requirements of some private standards.

Any change in one or more elements of these GAPs (increase in the dosages, 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 account locally of the severity of attacks and the real risks of damage.

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.

Some GAP (highlighted with yellow boxes in the tables thereafter) was tested by PIP on bittermelon in 2012 under tropical conditions in Dominican Republic.

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.

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.

Since cucurbits depend on bees for pollination, it is recommended that the use of insecticides is limited to a minimum during the flowering period.

Other PPPs not shown in the following tables can be effective, for example, neem extract (to control aphids, etc.), wood ash (to combat aphids, etc.) and soap solutions (to control spider mites, etc.). 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.

Others substances act as a physical trap or repellent on some small insects, nematodes and fungus and are not considered like conventional Plant Protection Products. For instance propylene glycol alginate, paraffin oil and maltodextrin can trap aphids, whiteflies, spider mites and leafhoppers as well as external fungus like powdery mildews when applied correctly. Calcined kaolin can repel various insects. Extract of Citrus can control various insects and mites by desiccating their skin. These substances have no possible resistance and no residues of concern but one should check locally authorization for use on crops.

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

Red melon beetles - *Aulacophora africana* and *Monolepta* sp.

Strategy: Since red melon beetle is often observed in association with melon ladybird beetle, insecticide applications used to control the latter are sufficient. If necessary, one to two applications of a pyrethroid insecticide can control this pest.

African melon ladybird beetle - *Henosepilachna elaterii*

Strategy: In case of severe infestations on large surfaces, one or two applications of a pyrethroid insecticide can be enough to keep attacks under control. During the flowering period, it is important to use insecticides that are not toxic to pollinating insects. The underside of leaves must be carefully treated to reach the larvae found there

Cucurbit leaf-eating beetles - *Acalymma vittata* ou *Diabrotica undecimpunctata*

Strategy: Insecticide treatments are rarely necessary, except in cases of severe infestation.

Active substance	Crop	Recommended GAP*					Proposed application period							
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 3 – Pyrethroids														
alpha-cypermethrin	all cucurbits with edible peel	30	1	n.a.	3	7	/							
bifenthrin	all cucurbits with edible peel	20	/	/	7	/	/							
beta-cyfluthrin	cucumbers and courgettes	17,5	2	/	3	/	14							
	others cucurbits with edible peel	17,5	2	/	14	/	14							
cypermethrin	all cucurbits with edible peel	50	2	7	2	2	6							
deltamethrin	all cucurbits with edible peel	12,5	3	7	3	3	/							
lambda-cyhalothrin	all cucurbits with edible peel	26,3	2	10	2	6	10							
pyrethrin	all cucurbits with edible peel	100	/	/	2	2	2							
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists														
acetamiprid	all cucurbits with edible peel	50	2	7	3	3	/							
imidacloprid	cucumbers and courgettes	/	/	/	7	7 only for cucumbers	/							
	others cucurbits with edible peel	/	/	/	/	/	/							
thiamethoxam	all cucurbits with edible peel	100	2	16	2	2	6							
Group N – Compounds of unknown or uncertain MoA														
azadirachtin	cucurbits with edible peel	/	/	/	2	2	2							
Group 1 – Organophosphates and carbamates														
malathion	all cucurbits with edible peel	1.000	2	/	21	21 only for cucumbers	/							
chlorpyrifos-methyl	all cucurbits with edible peel	800	/	/	14	/	14							

* The elements of the recommended GAP shown here is the worst case that allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide for MRLs value). One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available
n.a.: not applicable

Cucurbit fruit flies - *Dacus* spp. , *Bactrocera* spp.

Strategy: Insecticide treatments do not reach eggs or larvae inside the fruit, or pupae. They should target adults only, to prevent egg-laying in fruit at the sensitive stage. To improve their effectiveness, bait (protein hydrolysisate, sugar water) can be added to the insecticide mixtures, which will be sprayed in a steady stream on nurse crops near the crop, see <http://www.cirad.fr/en/research-operations/research-results/2012/maize-plants-that-trap-vegetable-flies> . Insecticides are applied to the crop itself from the start of flowering or setting at intervals of one week in cases of severe infestation. It is essential to use insecticides that are not toxic to pollinating insects. With furrow irrigation we avoid to wash-off products on foliage and prolong the effectiveness of treatment. Treatment with kaolon has also shown quite good efficacy in trials implemented by COLEACP/PIP. It is highly recommended to use the technique of augmentorium to help to control this pest. See <http://cdn.intechopen.com/pdfs-wm/29600.pdf> and http://gamour.cirad.fr/site/index.php?option=com_docman&task=cat_view&gid=41&Itemid=84

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1 – Organophosphates and carbamates														
malathion	all cucurbits with edible peel	1.000	2	/	21	21 only for cucumbers	/							
Group 3 – Pyrethroids														
bifenthrin	all cucurbits with edible peel	40	/	/	7	/	/							
deltamethrin	all cucurbits with edible peel	12,5	3	7	3	3	/							
lambda-cyhalothrin	all cucurbits with edible peel	26,3	2	10	2	6	10							
Group 5 – Spinosines														
spinosad	all cucurbits with edible peel	144	2	7	2	2	6							

A ready to use formulation of spinosad + attractant should be preferably applied in spot treatment on maize as a trap crop. Since the product is applied on maize, there is no pre-harvest interval to be observed on the crop.

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** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

American leafminer fly - *Liriomyza trifolii*

Strategy: Broad-spectrum insecticides (pyrethroids), used at regular intervals to control other pests, can destroy auxiliaries and provoke explosions in the population of American leafminer fly. In case of serious infestations, detected by the presence of numerous feeding bites and tunnels, only selective insecticides (cyromazine, etc.), which are often costly, or acaricide insecticides (abamectin) should be used. Treatment at the start of growth can be enough to control the pest throughout the cultivation period. Plants must be completely free of this pest when they leave the nursery..

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 6 – Avermectins														
abamectin	all cucurbits with edible peel	18	4	7	2	2	2							
Groupe 5 – Spynosines														
spinetoram	all cucurbits with edible peel	72	2	7	2	/	6							

* The elements of the recommended GAP shown here is the worst case that allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide for MRLs value). One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Whitefly - *Bemisia tabaci*

Strategy: Plants must be kept free of the pest in the nursery and during the early stages of their development. When the plants are older, treatments can generally be staggered over longer intervals.

In cases of severe infestation on growing plants, the use of insecticides should be considered to limit any weakening of the plant. A selective insecticide, such as buprofezin, spares auxiliaries and is compatible with biological control. The same is true for insecticides such as pymetrozine, with its translaminar action that is limited to biting and sucking insects.

Applications should cover the underside of leaves thoroughly to reach adults and pupae.

It is recommended to alternate insecticides with different modes of action to limit the risk of resistance.

Broad-spectrum insecticides could be harmful to auxiliaries. The flowering period requires the use of insecticides that are not toxic to pollinating insects.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	DAR recommandé (jours)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1 – Organophosphates and carbamates														
methomyl	all cucurbits with edible peel	300	2	7	2	2	6							
dimethoate	all cucurbits with edible peel	/	/	/	28	/	28							

Active substance	Recommended GAP*							Proposed application period								
	Crop	Dosage g/ha	Maximum number applications	Minimal interval between applications (days)			Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
				EU MRL	Codex MRL	LOQ**	EU MRL	Codex MRL	LOQ**							
Group 3 – Pyrethroids																
alpha-cypermethrin	all cucurbits with edible peel	30	1	n.a.	3	7	/									
bifenthrin	all cucurbits with edible peel	20	/	/	7	/	/									
etofenprox	cucumber	500	3	7	2	/	14									
	others cucurbits with edible peel	500	3	7	14	/	14									
pyrethrin	all cucurbits with edible peel	100	/	/	2	2	2									
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists																
acetamiprid	all cucurbits with edible peel	50	2	7	3	3	/									
imidacloprid	cucumbers and courgettes	/	/	/	7	7 only for cucumbers	/									
	others cucurbits with edible peel	/	/	/	/	/	/									
thiacloprid	all cucurbits with edible peel	190	3	7	3	3 cucumbers and courgettes 14 others	14									
thiamethoxam	all cucurbits with edible peel	100	2	16	2	2	6									
Group N – Compounds of unknown or uncertain MoA																
azadirachtin	all cucurbits with edible peel	/	/	/	2	2	2									
Group 23 – Inhibitors of acetyl CoA carboxylase																
spirotetramat	all cucurbits with edible peel	75	3	7	3	3	14									
Group 9																
pymetrozine	all cucurbits with edible peel	200	3	7	3	/	/									

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One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Thrips - *Ceratothripoides cameroni*, *Frankliniella occidentalis* and *Thrips* sp.

Strategy: Interventions must begin in the nursery and be continued on young plants. Avoid wherever possible the repeated use of broad-spectrum insecticides (pyrethroids), which are harmful to auxiliaries. The flowering period requires the use of insecticides that are not toxic to pollinating insects.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1 – Organophosphates and carbamates														
chlorpyrifos-methyl	all cucurbits with edible peel	800	/	/	14	/	14							
malathion	all cucurbits with edible peel	1.000	2	/	21	21 only for cucumbers	/							
methomyl	all cucurbits with edible peel	300	2	7	2	2	6							
Group 3 – Pyrethroids														
bifenthrine	all cucurbits with edible peel	20	/	/	7	/	/							
deltaméthrine	all cucurbits with edible peel	12,5	3	7	3	3	/							
pyréthrine	all cucurbits with edible peel	100	/	/	2	2	2							
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists														
acétamipride	all cucurbits with edible peel	50	2	7	3	3	/							
imidaclopride	cucumbers and courgettes	/	/	/	7	7 only for cucumbers	/							
	others cucurbits with edible peel	/	/	/	/	/	/							
thiaclopride	all cucurbits with edible peel	190	3	7	3	3 cucumber and courgettes 14 others	14							
thiamethoxam	all cucurbits with edible peel	100	2	16	2	2	6							
Group 5 – Spynosines														
spinetoram	all cucurbits with edible peel	72	2	7	2	/	6							
spinosad	all cucurbits with edible peel	144	2	7	2	2	6							
Group 6 – Avermectins														
abamectine	all cucurbits with edible peel	18	4	7	2	2	2							
Group 23 – Inhibitors of acetyl CoA carboxylase														
spirotetramat	all cucurbits with edible peel	75	3	7	3	3	14							
Not classified														
oxymatrine	all cucurbits with edible peel	/	3	7	2	2	2							

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** PHI based on the EU LOQ value
/ elements of the recommended GAP not available

Webworm - *Diaphania* spp.

Strategy: Inspection of young plants allows early detection of the first attacks, which, in case of a significant infestation, generally necessitate only a single application of an insecticide. Interventions are sometimes necessary to protect fruit.

Active substance	Recommended GAP*							Proposed application period						
	Crop	Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Sowing	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1 - Organophosphates and carbamates														
methomyl	all cucurbits with edible peel	300	2	7	2	2	6							
Group 3 - Pyrethroids														
alpha-cypermethrin	all cucurbits with edible peel	30	1	n.a.	3	3	/							
beta-cyfluthrin	cucumbers and courgettes	17,5	2	/	3	/	14							
	others cucurbits with edible peel	17,5	2	/	14	/	14							
bifenthrin	all cucurbits with edible peel	20	/	/	7	/	/							
deltamethrin	all cucurbits with edible peel	12,5	3	7	3	3	/							
lambda-cyhalothrin	all cucurbits with edible peel	26.3	2	10	2	6	10							
Group 5 - Spinosins														
spinetoram	all cucurbits with edible peel	72	2	7	2	/	6							
spinosad	all cucurbits with edible peel	144	2	7	2	2	6							
Group 11 - Microbial disruptors of insect midgut membranes														
<i>Bacillus thuringiensis var kurstaki</i>	all cucurbits with edible peel	/	repeat as required	7	2	2	2							
Group N - Compounds of unknown or uncertain MoA														
azadirachtin	all cucurbits with edible peel	/	/	/	2	2	2							
Group 22 - Voltage-dependent sodium channel blockers														
indoxacarb	all cucurbits with edible peel	37,5	3	7	3	3	/							
Group 6: Avermectins														
emamectin benzoate	all cucurbits with edible peel	20	3	7	3	3	3							
Group 28 - Ryanodine receptor modulators														
chlorantraniliprole	all cucurbits with edible peel	35	2	7	3	3	/							

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** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Aphid - *Aphis gossypii*

Strategy: Localised treatments must begin as soon as the first signs of infestation have been detected to keep the population of aphids at an economically acceptable level. To lessen the impact of insecticide treatments on auxiliary insects (beetles, syrphus flies), specific insecticides (aphicides) should be chosen (pirimicarb, pymetrozine). Pymetrozine provides translaminar and fast action, leading to an immediate halt of feeding. It is recommended to alternate insecticides with different modes of action to limit the risk of resistance. Be sure to wet the underside of leaves thoroughly to reach the aphids. The flowering period requires the use of insecticides that are not toxic to pollinating insects.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1 – Organophosphates and carbamates														
chlorpyrifos-methyl	all cucurbits with edible peel	800	/	/	14	/	14							
dimethoate	all cucurbits with edible peel	/	/	/	28	/	28							
methomyl	all cucurbits with edible peel	300	2	7	2	2	6							
pirimicarb	all cucurbits with edible peel	375	2	/	3	3	/							
Group 3 – Pyrethroids														
bifenthrin	all cucurbits with edible peel	20	/	/	7	/	/							
lambda-cyhalothrin	all cucurbits with edible peel	26,3	2	10	2	6	10							
pyrethrin	all cucurbits with edible peel	100	/	/	2	2	2							
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists														
acetamiprid	all cucurbits with edible peel	50	2	7	3	3	/							
imidacloprid	cucumbers and courgettes	/	/	/	7	7 only for cucumbers	/							
	others cucurbits with edible peel	/	/	/	/	/	/							
thiacloprid	all cucurbits with edible peel	190	3	7	3	3 cucumber and courgettes 14 others	14							
thiamethoxam	all cucurbits with edible peel	100	2	16	2	2	6							
Group 9														
pymetrozine	all cucurbits with edible peel	200	3	7	3	/	/							
Not classified														
oxymatrine	all cucurbits with edible peel	/	3	7	2	2	2							

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** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Red spider mite - *Tetranychus* sp.

Strategy: Selective acaricides should be used, with an alternation to limit risks of resistance and to minimise the negative impact on auxiliaries, including predator acarids (Phytoseiidae). As soon as the first symptoms have been detected, and if the attack starts to spread, treatments should be envisaged, either with specific acaricides having ovicide and/or larvicide action, or with insecticides having an acaricide effect (abamectin, pyrethroids with acaricide action). Pyrethroids with acaricide action can control most insects present at the time of treatment. Certain fungicides (sulphur) used to control powdery mildew slow the development of spider mites. For repeated applications, it is advisable to alternate the use of active substances with different types of action to limit the development of resistance. To the extent that attacks are limited in space, it is sometimes possible and useful to concentrate applications on the infested areas.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 3 – Pyrethroids														
bifenthrin	all cucurbits with edible peel	40	/	/	7	/	/							
Group 6 – Avermectins														
abamectin	all cucurbits with edible peel	18	4	7	2	2	2							
Not classified														
sulphur	all cucurbits with edible peel	6.400	7	7	2	2	2							
oxymatrin	all cucurbits with edible peel	/	3	7	2	2	2							
Group 12														
tetradifon	all cucurbits with edible peel	/	/	/	14	14	14							

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** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Root-knot nematode - *Meloidogyne* spp.

Strategy: In case of absolute necessity, nematicides, which are often expensive and toxic, can be applied at sowing, on the strips or in planting hole, avoiding generalised application.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Groupe 1 – organophosphorés et carbamates														
ethoprophos	all cucurbits with edible peel	10.000	1	n.a.	30	30	30							
carbofuran	all cucurbits with edible peel	1.635	at planting	n.a.	94	/	94							
carbosulfan	all cucurbits with edible peel	300	at planting	n.a.	94	/	94							
oxamyl	all cucurbits with edible peel	480	at planting	n.a.	94	/	94							

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** PHI based on the EU LOQ value
/ elements of the recommended GAP not available
n.a.: not applicable

Wilt or fusariosis - *Fusarium solani*, *Fusarium oxysporum* f.sp. *cucumerinum*

Strategy: Only cultivation methods and the use of resistant varieties can reduce the impact of the disease. Disinfection of tools (bleach) limits the propagation of the disease.

Anthracnose - *Colletotricum orbiculare*

Strategy: Seeds treatment (thiram, captan). This fungus is soil borne so it is useful to treat the soil.

Gummy stem blight - *Didymella bryoniae*

Strategy: It is difficult to control, particularly with high humidity and frequent rains. If the control of the disease is well done on stems and leaves, fruits damage are reduced in the field and at post harvest. Fungicides applications to control anthracnose are usually also effective on *Didymella*.

Scab of cucurbits - <i>Cladosporium cucumerinum</i>														
Strategy: Seeds treatment (thiram). Spraying of fungicides.														
Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 11: QoI fungicides														
azoxystrobin	all cucurbits with edible peel	250	3	7	2	2	10							
Group M: Multisite activity														
captan	cucumbers	/	/	/	/	2 only cucumbers	/							
chlorothalonil	all cucurbits with edible peel	1.500	4	7	2 cucumbers 18 others	2 cucumbers 2 courgettes 18 others	18							
mancozeb	all cucurbits with edible peel	1.600	4	7	2	2 cucumbers 6 courgettes > 21 others	> 21							
maneb	all cucurbits with edible peel	1.600	/	/	3	/	/							
thiram	all cucurbits with edible peel	/	1 (seeds)	n.a.	n.a.	n.a.	n.a.							

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One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

n.a. : not applicable

Powdery mildew – *Sphaerotheca fulginea*, *Erysiphe cichoracearum*

Strategy: As soon as symptoms appear or as soon as fruit has formed during the period favourable to the disease, fungicides (triazole, strobilurin or pyrimidin) should be used. Only authorised products should be used, in the recommended doses and observing the pre-harvest interval. Fungicide treatments should alternate active substances with different families and types of action to avoid the rapid development of strains of resistant fungi. Wettable sulphur, for preventive use, must not be used at temperatures of over 28°C (phytotoxicity).

WARNING: a slight phytotoxicity could be observed on zucchini.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 1: MBC fungicides														
carbendazim	all cucurbits with edible peel	600	2	7	6	2 courgettes 10 cucumbers 18 others	6							
thiophanate-methyl	all cucurbits with edible peel	700	/	/	/	/	/							
Group 3: DMI fungicides														
difenoconazole	all cucurbits with edible peel	125	4	10	7	/	/							
myclobutanil	all cucurbits with edible peel	75	4	7	3	/	/							
tebuconazole	all cucurbits with edible peel	/	/	/	/	/	/							
triadimenol	all cucurbits with edible peel	125	2	21	7	7	14							
triadimefon	all cucurbits with edible peel	125	2	21	7	7	14							
Group 11: QoI fungicides														
azoxystrobin	all cucurbits with edible peel	250	3	7	2	2	10							
trifloxystrobin	all cucurbits with edible peel	250	3	7	6	6	10							
Group M: Multisite activity														
sulphur	all cucurbits with edible peel	6.000	2	/	2	2	2							
Not classified														
<i>Ampelomyces quisqualis</i>	all cucurbits with edible peel	/	4	7	2	2	2							

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** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Downy mildew - *Pseudoperonospora cubensis*

Strategy: In the case of intensive cultivation in climate conditions favourable to the disease, fungicide treatments will be applied wetting the underside of the leaves thoroughly and applying the treatment within a few hours of a sprinkler irrigation. As preventive treatment and during low-risk periods, dithiocarbamate (maneb, mancozeb, etc.) should be applied weekly or twice a week in case of abundant dew. As soon as the first symptoms appear and during high-risk periods, phenylamide (metalaxyl-M...), strobilurins (azoxystrobin...) and chlorothalonil provide good control of the disease. They should be used only every 10 days because they are more persistent.

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group 4: Fongicides Phényl Amides														
metalaxyl-M***	all cucurbits with edible peel	100	3	7	6	6 cucumbers 6 courgettes > 21others	>21							
Group 11: QoI fungicides														
azoxystrobin	all cucurbits with edible peel	250	3	7	2	2	10							
famoxadone	all cucurbits with edible peel	112,5	3	10	10	/	/							
Group 27: Cyanoacetamide-oximes														
cymoxanil	all cucurbits with edible peel	150	3	10	10	/	/							
Groupe 33 - Phosphonates														
fosetyl-AI	all cucurbits with edible peel	3.200	4	/	14	/	/							
Group M: Multisite activity														
chlorothalonil	all cucurbits with edible peel	1.500	4	7	2 cucumbers 18 others	2 cucumbers 2 courgettes 18 others	18							
copper	all cucurbits with edible peel	/	/	/	20	/	/							
mancozeb***	all cucurbits with edible peel	1.600	3	7	6	6 cucumbers 6 courgettes > 21others	>21							
maneb	all cucurbits with edible peel	1.600	/	/	3	/	/							
propineb	all cucurbits with edible peel	2.000	/	7	3	3 cucumbers 3 courgettes > 21others	/							

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** PHI based on the EU LOQ value

*** mixed in the same product (mancozeb 640g/kg + metalaxyl-M 40 g/kg)
/ elements of the recommended GAP not available

Collar rot – <i>Pythium aphanidermatum</i>																
Strategy: Apply preferably as a preventive treatment in the nursery substratum or at the foot of plants in the field.																
Active substance	Crop	Recommended GAP*						Proposed application period								
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest		
					EU MRL	Codex MRL	LOQ**									
Group 4: Phenyl amide fungicides																
metalaxyl-M	all cucurbits with edible peel	180	3	10	7 cucumbers / others	7 cucumbers / 7 courgettes / others	/									
metalaxyl-M***	all cucurbits with edible peel	100	3	7	6	6 cucumbers / 6 courgettes / > 21others	>21									
Group 1: MBC fungicides																
carbendazim	all cucurbits with edible peel	600	2	7	6	2 courgettes / 10 cucumbers / 18 others	6									
Groupe M: Multisite activity																
mancozeb***	all cucurbits with edible peel	1.600	3	7	6	6 cucumbers / 6 courgettes / > 21others	>21									
Group 28 – Carbamates																
propamocarb HCl	all cucurbits with edible peel	see below		20	20	/										

The usual doses are as follows for a commercial product at 722 g/l:

In the field: Preventive use: 100 ml/plant of a 0.1% mixture, used to water the base of the plant or for drip watering, 1-2 applications at an interval of 14 days
 – Curative use: 100-150 ml/plant (200 ml to control *Pythium aphanidermatum*) of a 0.1% concentration, used to water the base of the plant or for drip watering, 1-2 applications at an interval of 7 days.

In the nursery: 5 l/m² of a 0.1% mixture, on the mounds or the seed bed.

* The elements of the recommended GAP shown here is the worst case that allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide for MRLs value).
 One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Angular leaf spot of cucumber – *Pseudomonas syringae* pv. *Lachrymans*

Strategy: When detected at an early stage, the disease can be kept fairly well under control using applications of copper

Active substance	Crop	Recommended GAP*						Proposed application period						
		Dosage g/ha	Maximum number applications	Minimal interval between applications (days)	Pre-harvest interval (days)			Soil preparation	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to final harvest
					EU MRL	Codex MRL	LOQ**							
Group M: Multisite activity														
copper	all cucurbits with edible peel	800	/	/	20	/	/							

* The elements of the recommended GAP shown here is the worst case that allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide for MRLs value). One should check on label of the product which dose fit to the targeted pest or disease.

** PHI based on the EU LOQ value

/ elements of the recommended GAP not available

Sources of GAP validated by PIP trials (boxes highlighted in yellow in previous pages) on bitter melon

Active substance	Commercial product tested	Concentration	Manufacturer	Trials	
				Year	Country
Abamectin	Vertimec 1.8 EC	18 g/l	Syngenta	2012	Dominican Republic
Azoxystrobin	Amistar 50 WG	500 g/kg	Syngenta	2012	Dominican Republic
Carbendazim	Carbendazim 500 SC	500 g/l	Agriphar	2012	Dominican Republic
Carbofuran	Furadan 3G	30 g/kg	FMC	2012	Dominican Republic
Carbosulfan	Marshal 20 EC	200 g/l	FMC	2012	Dominican Republic
Chlorothalonil	Bravo 500 SC	500 g/l	Syngenta	2012	Dominican Republic
Cypermethrin	Cyper 250 EC	250 g/l	Agriphar	2012	Dominican Republic
Lambda-cyhalothrin	Karate 1,75 EC	17,5 g/l	Syngenta	2012	Dominican Republic
Mancozeb	Dithane 80 NT	800 g/kg	Dow AgroSciences	2012	Dominican Republic
Mancozeb + metalaxyl-M	Ridomil Gold	640 + 40 g/kg	Syngenta	2012	Dominican Republic
Methomyl	Lannate 90	900 g/kg	Dupont	2012	Dominican Republic
Oxamyl	Vydate 24 SL	240 g/l	Dupont	2012	Dominican Republic
Spinetoram	Radiant 120 SC	120 g/l	Dow AgroSciences	2012	Dominican Republic
Spinosad	Spinoace 12 SC	120 g/l	Dow AgroScience	2012	Dominican Republic
Thiamethoxam	Actara 25 WG	250 g/kg	Syngenta	2012	Dominican Republic
Trifloxystrobin	Tega 25 SC	250 g/l	Bayer CropScience	2012	Dominican Republic

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

Remarks: Since lists of registered products change, this information should be tallied with the legislation in force locally in each area of production.

As an example, in the tables below are listed the active substances which are included in products registered for use on various crops, vegetables or specifically cucurbits in Kenya, Côte d'Ivoire, Ghana and by CSP (Sahelian Committee on Pesticides) for Burkina, Cabo Verde, Chad, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, The Gambia.

Insecticides and acaricides

Active substance	Kenya	CSP	Côte d'Ivoire	Ghana
Abamectin	Vegetable	Vegetable	Vegetable	Vegetable
Acetamiprid	Cucurbits – Zucchini	Vegetable	Vegetable	Vegetable
Alpha-cypermethrin	All crops	/	/	Vegetable
Azadirachtin	Cucurbits	/	/	/
<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Vegetable	/	Vegetable	Vegetable
Beta-cyfluthrin	/	/	/	Vegetable
Bifenthrin	Vegetable	/	Vegetable	/
Chlorantraniliprol	/	All crops	/	/
Chlorpyrifos-methyl	/	Vegetable	/	/
Cypermethrin	Vegetable	Vegetable	Vegetable	Vegetable
Deltamethrin	Vegetable	/	Vegetable	Vegetable
Dimethoate	/	Vegetable	/	Vegetable
Emamectin benzoate	/	/	/	/
Etofenprox	/	/	Vegetable	/
Imidacloprid	Cucumber	/	Vegetable	Vegetable
Indoxacarbe	/	/	Vegetable	/
Lambda-cyhalothrin	Vegetable	Vegetable	Vegetable	Vegetable
Malathion	Vegetable	/	Vegetable	/
Maltodextrin	/	/	/	Vegetable
Methomyl	Vegetable	Vegetable	/	/
Oxymatrin	/	/	/	Vegetable
Pirimicarb	Vegetable	/	/	/
Pyrethrin	Vegetable	/	/	/
Spinetoram	/	/	/	/
Spinosad	Vegetable	/	/	/
Spirotetramate	/	/	/	Vegetable
Tetradifon	Vegetable	/	/	/
Thiacloprid	Bitter melon and vegetable	/	/	/
Thiamethoxam	Vegetable	/	Vegetable	Vegetable

Fungicides

Active substance	Kenya	CSP	Côte d'Ivoire	Ghana
<i>Ampelomyces quisqualis</i>	Courgette (Zucchini)	/	/	/
Azoxystrobine	/	Vegetable	Vegetable	Vegetable
Captan	/	/	/	Vegetable
Carbendazim	/	/	Vegetable	Vegetable
Chlorothalonil	Cucumber	/	Vegetable	/
Copper	Vegetable - Cucurbits	/	Vegetable	Vegetable
Cymoxanil	Vegetable - Cucurbits	/	/	/
Difenoconazole	/	/	/	Vegetable
Famoxadone	Cucurbits			
Fosetyl-Al	Cucurbits	/	/	Vegetable
Mancozeb	Vegetable - Cucurbits - Cucumber	Vegetable	Vegetable	Vegetable
Manebe	/	/	Vegetable	Vegetable
Metalaxyl-M	Vegetable	All crops (on seeds)	Vegetable	Vegetable
Myclobutanil	/	Vegetable	/	/
Propineb	Vegetable - Cucurbits	/	/	Vegetable
Sulfur	Vegetable - Cucumber	/	/	Vegetable
Tebuconazole	Vegetable	/	Vegetable	Vegetable
Thiophanate-methyl	/	/	/	Vegetable
Thiram	/	For seeds	/	For seeds
Triadimefon	Vegetable	/	/	
Triadimenol	Vegetable	/	/	/
Trifloxystrobine	/	/	Vegetable	Vegetable

Nematicides

Active substance	Kenya	CSP	Côte d'Ivoire	Ghana
Cadusafos	/	/	/	Vegetable
Carbofuran	Vegetable	/	Vegetable	Vegetable
Ethoprophos	Vegetable	All crops	Vegetable	Vegetable
Oxamyl	/	/	Vegetable	Vegetable

6. European regulations and pesticide residues

Status of the active substances in Regulation 1107/2009; European MRL and Codex MRL in December 2014

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	Status Reg 1107/2009	European regulation				Codex MRL		
		European MRL						
		all cucurbits with edible peel	cucumbers	Courgettes**	other cucurbits with edible peel	all cucurbits	cucumbers	Courgettes
Abamectin	Approved	0,02	0,02	0,02	0,02	/	0,01*	0,01*
Acetamiprid	Approved	0,3	0,3	0,3	0,3	0,2	0,2	0,2
Alpha-cypermethrin	Approved	0,2	0,2	0,2	0,2	0,07	0,07	0,07
<i>Ampelomyces quisqualis</i> strain AQ10	Approved	No MRL required				/	/	/
Azadirachtin	Approved	1	1	1	1	/	/	/
Azoxystrobin	Approved	1	1	1	1	1	1	1
<i>Bacillus thuringiensis</i>	Approved	No MRL required				/	/	/
Beta-cyfluthrin	Approved	/	0,1	0,1	0,02*	/	/	/
Bifenthrin	Approved	0,1	0,1	0,1	0,1	/	/	/
Captan	Approved	0,02*	0,02*	0,02*	0,02*	/	3	/
Carbendazim	Not approved	0,1*	0,1*	0,1*	0,1*	/	0,05*	0,5
Carbofuran	Not approved	0,01*	0,01*	0,01*	0,01*	/	/	/
Carbosulfan	Not approved	0,01*	0,01*	0,01*	0,01*	/	/	/
Chlorantraniliprole	Approved	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Chlorothalonil	Approved	/	1	0,01*	0,01*	/	3	3
Chlorpyrifos-methyl	Approved	0,05*	0,05*	0,05*	0,05*	/	/	/
Copper	Approved	5	5	5	5	/	/	/
Cymoxanil	Approved	/	0,5	0,1	0,1	/	/	/
Cypermethrin	Approved	0,2	0,2	0,2	0,2	0,07	0,07	0,07
Deltamethrin	Approved	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Difenoconazole	Approved	0,3	0,3	0,3	0,3	/	/	/
Dimethoate	Approved	0,02*	0,02*	0,02*	0,02*	/	/	/
Emamectin benzoate	Approved	0,01*	0,01*	0,01*	0,01*	0,007	0,007	0,007
Ethoprophos	Approved	0,02	0,02	0,02	0,02	/	0,01*	/
Etofenprox	Approved	/	0,2	0,01*	0,01*	/	/	/
Famoxadone	Approved	0,2	0,2	0,2	0,2	/	0,2	0,2
Fosetyl-AI	Approved	75	75	75	75	/	/	/
Imidacloprid	Approved	/	1	1	0,5	/	1	/

* = LOQ

** included : summer squash, marrow (patisson), lauki (*Lagenaria siceraria*), chayote, sopropo/bitter melon, snake gourd, angled luffa/teroi

Active substance	Status Reg 1107/2009	European regulation				Codex MRL		
		European MRL						
		all cucurbits with edible peel	cucumbers	Courgettes**	other cucurbits with edible peel	all cucurbits	cucumbers	Courgettes
Indoxacarb	Approved	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Lambda-cyhalothrin	Approved	0,1	0,1	0,1	0,1	0,05*	0,05*	0,05*
Malathion	Approved	0,2	0,2	0,2	0,2	/	0,2	/
Mancozeb	Approved	2	2	2	2	/	2	1
Maneb	Approved	2	2	2	2	/	2	1
Mefenoxam (Metalaxyl-M)	Approved	/	0,5	0,05	0,05	/	0,5	0,2
Methomyl	Approved	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Myclobutanil	Approved	0,1	0,1	0,1	0,1	/	/	/
Oxamyl	Approved	0,01*	0,01*	0,01*	0,01*	/	2	/
Oxymatrine	Not listed	/	/	/	/	/	/	/
Pirimicarb	Approved	1	1	1	1	1	1	1
Propamocarb	Approved	10	10	10	10	5	5	5
Propineb	Approved	2	2	2	2	/	2	1
Pymetrozine	Approved	0,5	0,5	0,5	0,5	/	/	/
Pyrethrins	Approved	1	1	1	1	0,05*	0,05*	0,05*
Spinetoram	Approved	0,2	0,2	0,2	0,2	/	/	/
Spinosad	Approved	/	1	0,2	0,2	0,2	0,2	0,2
Spirotetramat	Approved	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Sulphur	Approved	No MRL required				/	/	/
Tebuconazole	Approved	/	0,2	0,2	0,02*	/	0,15	0,2
Tetradifon	Not approved	0,01*	0,01*	0,01*	0,01*	/	/	/
Thiacloprid	Approved	0,3	0,3	0,3	0,3	/	0,3	0,3
Thiamethoxam	Approved	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Thiophanate-methyl	Approved	0,1*	0,1*	0,1*	0,1*	/	0,05*	0,5
Thiram	Approved	2	2	2	2	/	2	1
Triadimefon	Not approved	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Triadimenol	Approved	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Trifloxystrobin	Approved	0,2	0,2	0,2	0,2	0,3	0,3	0,3

* = LOQ

** included : Summer squash, marrow (patisson), lauki (Lagenaria siceraria), chayote, sopropo/bitter melon, snake gourd, angled luffa/teroi

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/pesticides/index_en.htm. Current status of active substances can be checked at http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection&language=EN.

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?event=pesticide.residue.selection&language=EN

See also the leaflet "New 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.

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>.

7. Annexes

1. References and useful documents

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2. Web sites

Cucumber

http://esa.confex.com/esa/2001/techprogram/paper_3018.htm
http://edis.ifas.ufl.edu/BODY_P1041 (university of Florida)
<http://www.infoagro.com/hortalizas/pepino.asp>
<http://www.nysaes.cornell.edu/recommends/18frameset.html>
<http://edis.ifas.ufl.edu/VH031> (university of Florida)
<http://aggie-horticulture.tamu.edu/cucurbit/intro.html>
<http://vegdis.cas.psu.edu/VegDiseases/commercial/cucumbers.html>
<http://ipmwww.ncsu.edu/pamphlets/cucumber/cucumber.html>
<http://www.avrdc.org.tw/LC/cucurbits/publications.html>
http://www.agr.gc.ca/cal/epub/1684f/16840003_f.html (bibliothèque canadienne de l'agriculture)
<http://www.omafra.gov.on.ca/french/crops/facts/90-174.htm> (Ministère de l'agriculture, de l'alimentation et des affaires rurales – Ontario)
<http://www.extento.hawaii.edu/kbase/crop/crops/cucumber.htm>

Cucurbits

<http://www.extento.hawaii.edu/kbase/reports/recommendations/cucurbit.asp>
<http://www.avrdc.org.tw/LC/cucurbits/virus.html>
<http://www.avrdc.org/LC/cucurbits/publications.html>
http://www.hear.org/starr/hiplants/reports/html/coccinia_grandis.htm
<http://www.edpsciences.org/articles/fruits/abs/2001/03/monnerville/monnerville.html>
<http://www.inra.fr/Internet/Produits/HYPPZ/CULTURES/3c---116.htm> (INRA)
<http://www.ces.ncsu.edu/depts/pp/cucurbit/images.php> (cucurbit downy mildew - North american plant disease forecast center)
http://ipm.ncsu.edu/AG295/html/cucurbit_key.htm
<http://www.nysaes.cornell.edu/recommends/> (Cornell cooperative extension publication)
<http://www.ipmcenters.org/pmsp/pdf/TNcucurbit.pdf> (Tennessee's Pest management strategic plan for cucurbits)

Pests and diseases

Various

<http://www.uga.edu/vegetable/aphids.html>
<http://plant-disease.ipcc.orst.edu/> (Plant disease control – Oregon state university)
<http://www.ceris.purdue.edu/napis/pests/index.html>
<http://vegetablemndonline.ppath.cornell.edu/PhotoPages/PhotoGallery.htm#Cucurbit> (department of plant pathology, Cornell university, NY)
<http://everest.ento.vt.edu/~idlab/vegpests/vegfact.html>
<http://www.inra.fr/Internet/Produits/HYPPZ/ravageur.htm>
<http://vegdis.cas.psu.edu/VegDiseases/identification.html>
<http://www.hort.uconn.edu/ipm/general/misc/contents.htm>
<http://perso.wanadoo.fr/claude.declert/>
http://www.fruits-et-legumes.net/phyto/prg/Recherche_Parasites2.asp?LISTEVAR=Recherche_Parasites2
http://ipm.ncsu.edu/AG295/html/Plate_Index.html
<http://plantpathology.tamu.edu/Textlab/index.htm#Vegetable> (Texas plant disease handbook)
<http://www.extension.umn.edu/distribution/horticulture/DG1172.html> (university of Minnesota)
<http://www.ipm.ucdavis.edu/PMG/selectnewpest.cucurbits.html> (UNIVERSITY OF California - IPM online)
<http://www.tpp.uq.edu.au/diseases.htm> (cooperative research center for tropical plant protection)

White flies

http://creatures.ifas.ufl.edu/veg/leaf/silverleaf_whitefly.htm

Fruit flies

<http://fruit-flies.netfirms.com/french/2f-ceratitiss.htm>

<http://portal.arenu.mu/modules.php?name=News&file=article&sid=63> (Agricultural research and extension unit)

<http://www.africamuseum.be/fruitfly/AfroAsia.htm>

Leaf miners

<http://www.gov.on.ca/OMAFRA/french/crops/facts/00-040.htm>

<http://www.cipotato.org/market/PgmRpts/pr99-00/18leafminr.pdf>

Aphids

http://res2.agr.ca/stjean/publication/web/aphidinae8_f.htm

Thrips

<http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7429.html>

<http://www.nysaes.cornell.edu/ent/hortcrops/english/thrips.html>

Seeds

http://www.tropical-seeds.com/index_main.html

<http://www.technisem.com/index.cfm?langue=fr&>

<http://www.possumpages.com.au/newgipps/frame.htm>

<http://perso.wanadoo.fr/jme.cordier/ep1.html>

http://www.barbadine.com/pages/sol.torvum_lien.htm

<http://www.centuryseeds.com/>

<http://www.seedquest.com/toadvertise/expos.htm>

<http://www.graines-baumaux.fr/>

<http://www.vilmorin.com/>

<http://www.heirloomseeds.com/>

<http://www.technisem.com/>

<http://www.seminis.com/>

<http://www.clauseitezier.com/fr/home/index.php>

<http://www.fermedesaintemathe.com/>

<http://www.sunseeds.com/>

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 (*Ipomoea batatas*)
Tamarillo (*Solanum betaceum*)
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)

