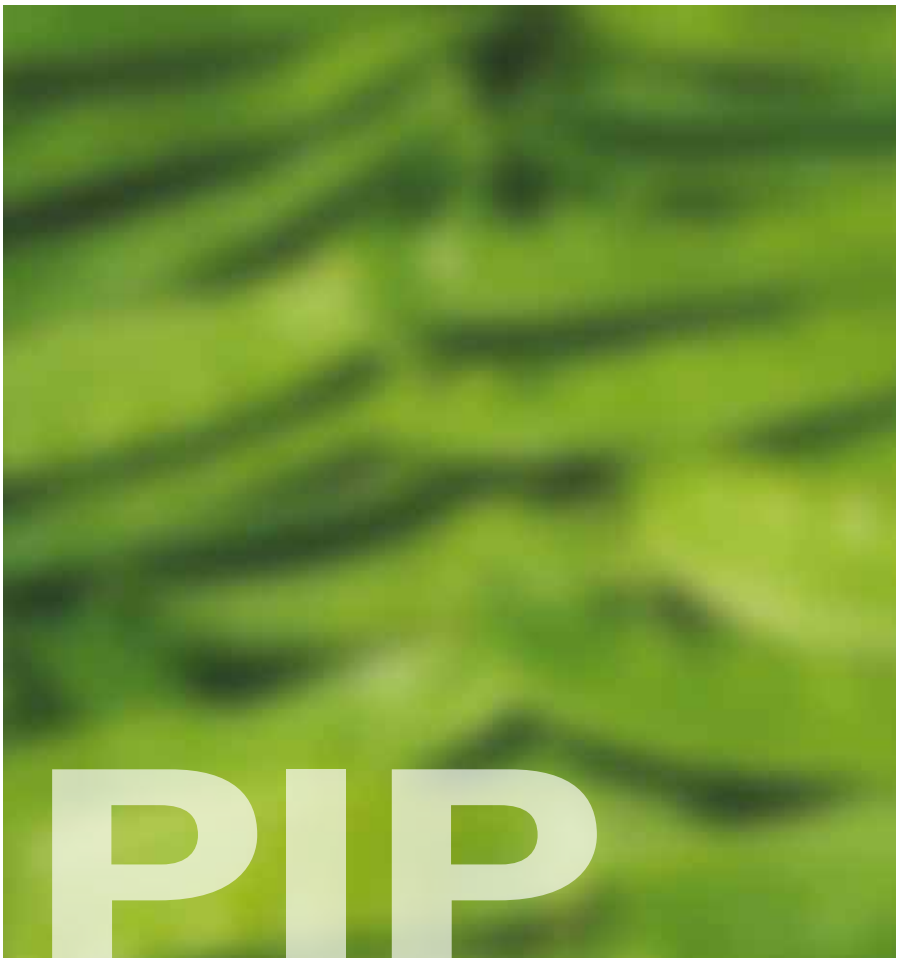

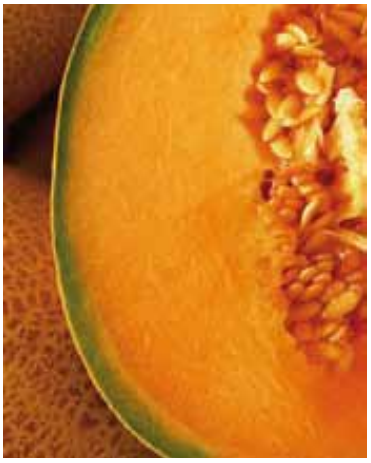

GUIDE TO GOOD CROP PROTECTION PRACTICES

FOR MELON (*CUCUMIS MELO*)

COLEACP is an international network promoting sustainable horticultural trade.

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

www.coleacp.org/pip

PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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NOTICE

The Guide to Good Plant Protection Practices (fruit or vegetable) details all plant protection practices (for fruits or vegetables) and recommends primarily the active substances supported by pesticides manufacturers in the framework of EU Regulation 1107/2009, which must comply with standards for pesticide residues. Most of these active substances have been tested through a field trials programme and the residue level of each active substance has been measured. The information given on the active substances suggested is 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

PIP
FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

Table of contents

1 – Main enemies of melon crops

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 "QO".

INSECTS						
Extent	Organs attacked		Types of loss			
	Leaves	Fruit	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Red melon beetle: *Aulacophora africana* and *Monolepta* sp.						
+	Holes bored by adults Stem near ground can also be attacked by larvae		Young plants die if attacked severely			
Melon beetle: *Henosepilachna elaterii*						
++		Eaten by adults and larvae	Young plants die if attacked severely			
Melon fruit fly: *Dacus vertebratus*, *Dacus ciliatus* QQ, *Bactrocera, cucurbitae* QQ						
+++		Larvae in fruit		Sharp decrease if fruit attacked at early stage		Fruit rots from inside
American leafminer fly: *Liriomyza trifolii* QQ						
++	Bitten into by adults and mined by larvae			Reduced if photosynthesis is significantly slowed due to extensive mining		

INSECTS (continued)

Extent	Organs attacked		Types of loss			
	Leaves	Fruit	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
White fly: *Bemisia tabaci* OQ						
++	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		Lower level of sugar in cases of severe attacks Honeydew depreciates market value of fruit
Thrips: *Ceratothripoides cameroni*, *Frankliniella occidentalis* OQ, *Thrips* sp.						
+++	Eaten by adults and larvae			Significant reduction if growth is slowed by severe attacks on young plants		
Melon moth: *Diaphania* (*Margaronia*) *indica*						
+	Eaten by larvae	Skin eaten by larvae				Market value reduced
Melon aphid: *Aphis gossypii*						
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		
Leaf-eating beetles: *Chrysomelidae*						
Acalymma vittata* - *Diabrotica undecimpunctata* OQ - *Asbecesta cyanipennis* - *Asbecesta transversa						
The most significant losses are not related directly to the feeding of the beetles, but to the transmission of bacterial wilt (*Erwinia tracheiphila*). Bacterial wilt kills the plant, resulting in a significant decrease in yield.						
+	Leaves and flowers eaten by adults Larvae also damage roots and lower stem	Skin eaten				Market value reduced

MITES

Extent	Organs attacked		Types of loss			
	Leaves	Fruit	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Red spider mite: *Tetranychus urticae*						
+++	Eaten by adults and larvae			Reduced if attack is severe		

NEMATODES

Extent	Organs attacked	Types of loss			
	Roots	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Root-knot nematode: *Meloidogyne* spp.					
The presence of *Meloidogyne* favours or aggravates attacks of fungi such as Fusarium (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 loss			
	Stem	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Fusarium* wilt, melon wilt: *Fusarium oxysporum* f.sp. *cucumerinum, Fusarium solani						
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	
Oidium: *Sphaerotheca fuliginea*, *Erysiphe cichoracearum*						
+++		Presence of the fungus on upper and lower surfaces	Loss of young plants if attacked at early stage	Reduced if photosynthesis is significantly slowed due to the presence of the fungus		Lower gustatory quality

FUNGI (continued)

Extent	Organs attacked		Types of loss			
	Stem	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Mildew: *Pseudoperonospora cubensis*						
+++		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		Mediocre quality
Stem and collar rot: *Pythium aphanidermatum*						
++	Development of mycelium inside the stem		Loss of young plants through damping-off			

BACTERIA

Extent	Organs attacked		Types of loss			
	Leaves	Fruit	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Angular leaf spot: *Pseudomonas syringae* pv. *lachrymans*						
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

VIRUSES

Extent	Organs attacked		Types of loss			
	Entire plant	Fruit	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
CMV (Cucumber Mosaic Virus)						
This viral disease, transmitted by aphids, can cause extensive loss of the crop.						
++	All organs can present discolourations or deformations			Significant reduction if growth is slowed by severe attack at early stage		

1.2 Identification and damage

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

INSECTS

Red beetle: *Aulacophora africana* and *Monolepta* sp.

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. The damage caused can be a place of entry for various fungi.

Monolepta | *Aulacophora*

Melon 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 translucid, take on a greyish colour and dry up. The young plants can dry up completely and die in cases of severe attack.

Larva | Adult

Melon fly: *Dacus* sp., *Bactrocera cucurbitae*

The females pierce the skin of very young fruit to lay a dozen or so eggs just beneath the skin. The skin of older melons 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).

Adult

Larvae

American leafminer fly: *Liriomyza trifolii*

The larvae burrow winding gallery into the leaves and the cotyledon. These burrow become progressively more wide as the larvae develop.

They become brown, looking leaf stain. They are visible on the upper side of the leaves.

Adult

Larvae

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 photo-synthesis. White fly is found on the lower surface of leaves.

Adults

Thrips: *Ceratothripoïdes cameroni*, *Frankliniella occidentalis*, *Thrips* sp.

Larvae and adults feed in colonies on the leaves, along the main and lateral veins, on the stems, mostly near growing extremities, on the flowers and on the surface of fruits. 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. The tissues on which the thrips feeds become leaden in appearance and "speckled"; they are severely discoloured, particularly the petals.

Larvae

Melon moth: *Diaphania (Margaronia) indica*

The caterpillars devour the foliage and eat into or make holes in the melon skin. Damage is often observed at places where the fruit touches a leaf or the ground.

Caterpillar

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).

Curcubit leaf eating beetles: *Acalymma vittata* or *Diabrotica undecimpunctata*, *Asbecesta gyanipennis*, *Asbecesta transversa*

The young larvae feed on the collar and stems of cucurbits. Adults feed on leaves, flowers and even on the fruit later in the season. The main damage is due to bacterial wilt; bacterial infection of the plant is facilitated by the presence of the beetles.

Diabrotica

Acalymma

MITES

Red spider mite: *Tetranychus urticae*

Acarids 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 plant is weakened. The leaf can also be covered with webbing.

Yellowing at upper face

Mites on the underleaf

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*).

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 occuring 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.

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, 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.

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.

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.

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.

VIRUSES

Mosaic CMV: *cucumber mosaic virus*

The melon 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.

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.

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

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

Stage	Length of stage	*Aulacophora*	*Henosepilachna elaterii*	*Dacus* sp. *Bactrocera cucrbitae*	*Liriomyza trifolii*	*Bemisia tabaci*	*Ceratothripoides cameroni, Thrips* sp. *Frankliniella occidentalis*	*Diaphania (Margaronia) indica*	*Aphis gossypii*	Leaf-eating beetles	*Tetranychus* sp.	*Meloidogyne* spp.	*Fusarium* sp.	*Erysiphe cichoracearum Sphaerotheca fuliginea*	*Pseudoperonospora cubensis*	*Pythium* sp.	CMV – *Cucumber mosaic virus*
Seeds																	
From sowing to emergence	One week																
From emergence to flowering	Five weeks																
From flowering to first harvest	Six to seven weeks																
From first harvest to peak of harvest	Two weeks																
From peak to final harvest	Two 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:

SEN = Senegal, MAU = Mauritania, DOR = Dominican Republic

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.

Melon beetle: *Henosepilachna elaterii*

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

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	+	+	+	+	++	++	++	++	++	++	+
MAU	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Cucurbit fly: *Dacus* sp., *Bactrocera cucurbitae*

Favourable climate conditions: In Africa, *Bactrocera cucurbitae* is present in Egypt, Kenya and Tanzania.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	++	+++	+++	+++	+++	+++	+++	+++	+++	++	+
MAU	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
DOR	/	/	/	/	/	/	/	/	/	/	/	/

American leafminer fly: *Liriomyza trifolii*

Favourable climate conditions: In the Sahel zone, this pest is more frequent in the dry season.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	++	++	++	++	+	0	0	0	0	+	+
MAU	+	++	++	++	+	0	0	0	0	0	+	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

White fly: *Bemisia tabaci*

Favourable climate conditions: High air humidity and high temperature favour infestations.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	+	+	+	+	0	0	0	0	0	+	+
MAU	+	+	++	++	0	0	0	0	0	0	0	0
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Thrips: *Ceratothripoïdes cameroni, Frankliniella occidentalis*, Thrips sp.

Favourable climate conditions: In the Sahel zone, during warm and rainy periods, damage is particularly high on watermelon and "wintering" melons. Serious damage in Senegal, in the Casamance region.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	+	+	+	+	++	+++	+++	+++	+++	+	+
MAU	++	+++	+++	+++	0	0	0	0	+	+	++	++
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Webworm: *Diaphania (Margaronia) indica*

Favourable climate conditions: No information.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	+	+	+	+	0	0	0	0	0	0	+
MAU	0	0	0	0	0	0	0	0	0	0	0	0
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Aphids: *Aphis gossypii*

Favourable climate 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
SEN	+	++	++	++	++	++	0	0	0	0	0	+
MAU					0	0	0	0	0	0	0	
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Red spider: *mite Tetranychus* sp.

Favourable climate conditions: Favoured by high temperatures (around 32°C) and dry weather.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	+	++	++	++	++	0	0	0	0	+	+
MAU	++	++	++	++	+	0	0	0	0	0	+	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Root-knot nematode: *Meloidogyne* spp.

Favourable climate conditions: Present throughout the year, but less so during the dry season in cool zones.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	++	++	++	++	++	++	++	++	++	++	++	++
MAU	++	++	++	++	++	++	++	++	++	++	++	++
DOR	/	/	/	/	/	/	/	/	/	/	/	/

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

Favourable climate 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
SEN	+	++	+++	+++	0	0	0	0	0	0	0	+
MAU	+	++	+++	+++	0	0	0	0	0	0	0	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Powdery mildew: *Erysiphe cichoracearum*

Favourable climate conditions: Warm weather (24 to 30°C), no rain, with relative humidity between 50 and 90%. Very high humidity is needed for spore germination. Powdery mildew is favoured by alternating humid (but rain-free) and dry periods.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	++	++	++	++	+	0	0	0	0	+	+
MAU	+	++	++	++	++	+	0	0	0	0	+	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Downy mildew: *Pseudoperonospora cubensis*

Favourable climate 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
SEN	+++	+++	+++	++	++	0	0	0	0	0	++	+++
MAU	+++	+++	+++	++	++	0	0	0	0	0	++	+++
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Collar rot: *Pythium aphanidermatum*

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

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	0	0	+	++	0	0	0	++	++	+	0	+
MAU	0	0	+	++	0	0	0	++	++	+	0	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Mosaic disease CMV (Cucumber Mosaic Virus)

Favourable climate conditions: More abundant in periods favourable to aphids.

Month	1	2	3	4	5	6	7	8	9	10	11	12
SEN	+	++	++	++	++	++	0	0	0	0	0	+
MAU	+	++	++	++	++	++	0	0	0	0	0	+
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Minor diseases and pests

	Red melon beetle *Aulacophora africana Monolepta* sp.	Melon aphid *Aspongopus viduatus*	Cucurbit leaf-eating beetles - *Acalymma vittata or Diabrotica undecimpunctata*	Angular leaf spot of cucumber - *Pseudomonas syringae pv. lachrymans*
Favourable conditions		Rainy season, abundant sprinkler irrigation	Warm period during and after irrigation	Heavy rains and high humidity with long periods where water is present on leaves. Driving rains with strong winds. Ideal temperatures between 24 and 28° C
SEN	+	+	X	X
MAU	0	0	0	0
DOR	/	/	/	/

2 – Main control methods

2.1. Introduction

Melon is a difficult crop to grow. Diseases are a permanent risk and are hard to foresee because of the lack of epidemiological data for many of them. The crop is also a target of insects, acarids and nematodes, which can cause serious economic damage.

In the field production of melons, downy mildew and powdery mildew are the major fungal diseases. The main pests are insects (melon fly, aphids, thrips, etc.) and nematodes.

General points on combating plant pests and diseases:
Sowing in compost in a nursery is preferable to sowing in situ. Plant protection is easier and more effective. The use of a healthy substratum and physical protection devices (insect nets, etc.) can help protect the plants from attacks by pests and soil-borne diseases.

Considering the significant threat to melon crops from pests and soil-borne diseases, the choice of a healthy soil is particularly important, without neglecting the main requirements of melon. The most favourable soils are deep, loose and well drained but "consistent", without being too heavy. It is best to choose soil with an aerated structure, a sufficient water reserve and good retention capacity. Sloping ground with pebbly surface soil over blackish clay is very suitable. Slightly limey soils (pH of between 6.0 and 7.5) are suitable; acid soils (under 5.6) are not recommended. Melon is particularly sensitive to deficiencies of molybdenum, linked to soil acidity, insufficient calcium and excess magnesium.

Chemical products are one way of combating 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 pupa*e, *Dacus* maggots and pupae, *Liriomyza*, white fly larvae, etc.).

In the case of chemical pesticides, for repeated applications to combat pests with short life-cycles and closely spaced generations (aphids, white-fly, 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.

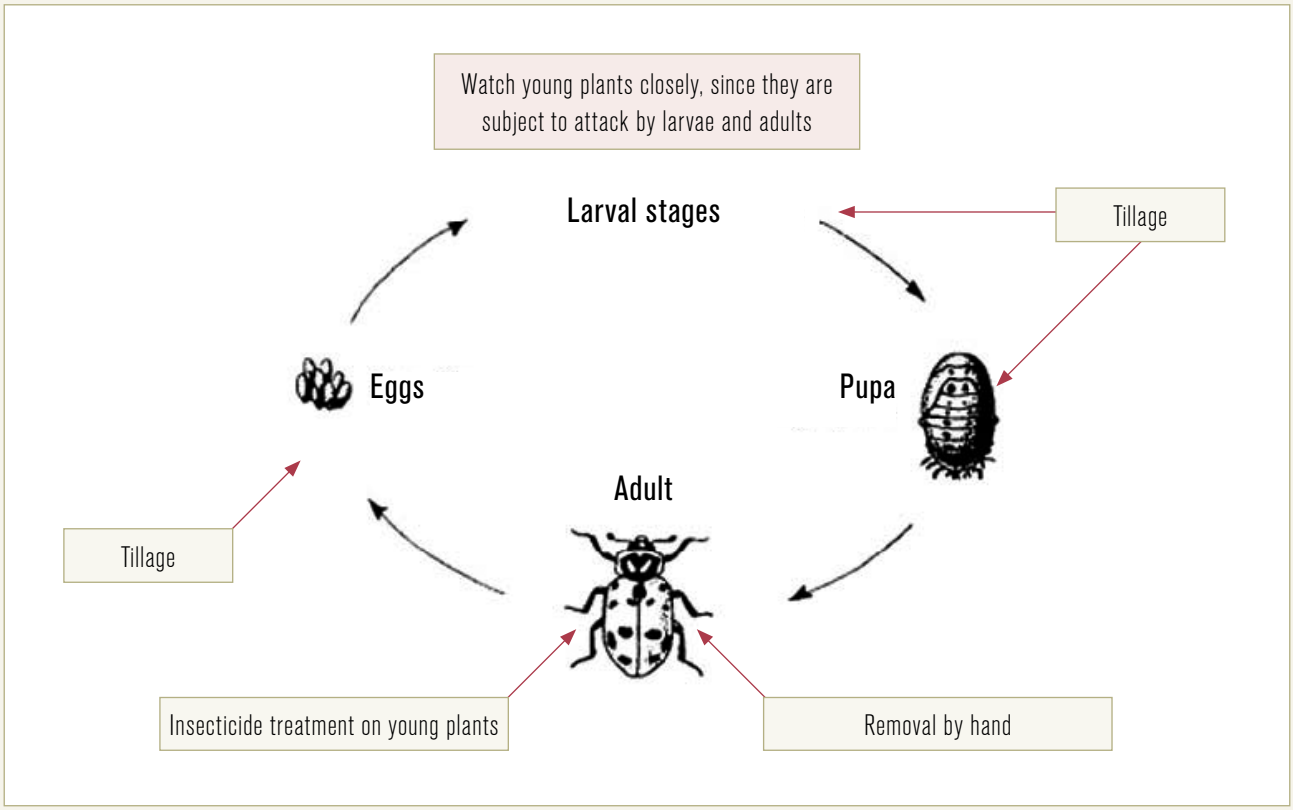
In the second column, actions that can be referred to as "cultivation practices" are shown in green boxes, and actions that can be referred to as "application of plant protection products", in orange boxes.

Cultivation practices
Application of plant protection product

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

RED BEETLE (*Aulacophora africana (Rhaphidopalpa foveicollis)* and *Monolepta* sp.)

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 adults by hand.
- Insecticide treatment for serious outbreaks.

Field

<u>During the production cycle, and particularly in the growth stage</u>

- Removal of adults by hand on small crops.
- Insecticide treatment on young plants in case of serious outbreak.

<u>After the final harvest</u>

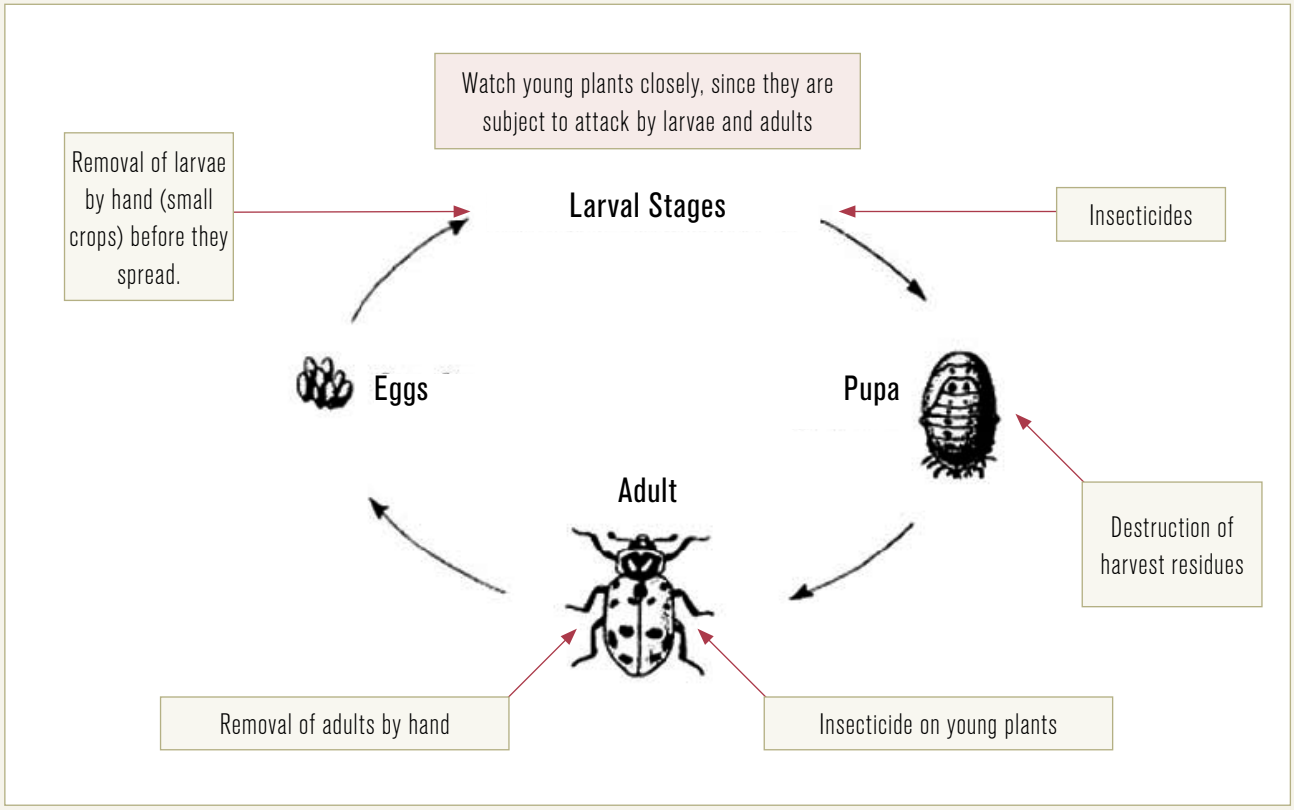
Tilling the soil after harvest can help reduce insects in the egg, larval and pupal stages.

Validity and relevance to be checked in local conditions:

- Keeping the soil dry can help eliminate eggs through desiccation.
- Furrow irrigation: the soil at the base of the plant remains dry, which is unfavourable to the development of the pest.

MELON BEETLE *(Henosepilachna 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.

CUCURBIT FLY (*Dacus* spp., *Bactrocera cucurbitae*)

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

Insecticide treatments should be used only on adults to prevent egg-laying in fruit during the sensitive stage(fruit measuring 8-10 cm in diameter).

N.B. cycle of a fruit fly on orange tree; lifecycle similar to that of melon fly

Protection of fruit at an early stage (< 8-10 cm diam.) using mechanical means (non-woven netting, etc.)

Reduction of the presence of adults in the area through the destruction of nearby wild cucurbits

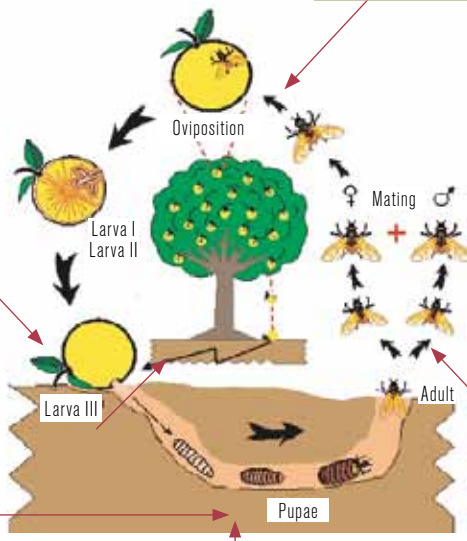
Removal and destruction of damaged fruit

Trapping with yellow-panel traps

Insecticide treatments

Superficial tillage of the soil to bring pupae to the surface

Abundant irrigation of infested fields can destroy some of the pupae



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

- On small crops, protection of fruit at an early stage (< 8-10 cm diam.), by surrounding them with non-woven netting, paper or double sacks to prevent the laying of eggs.
- 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

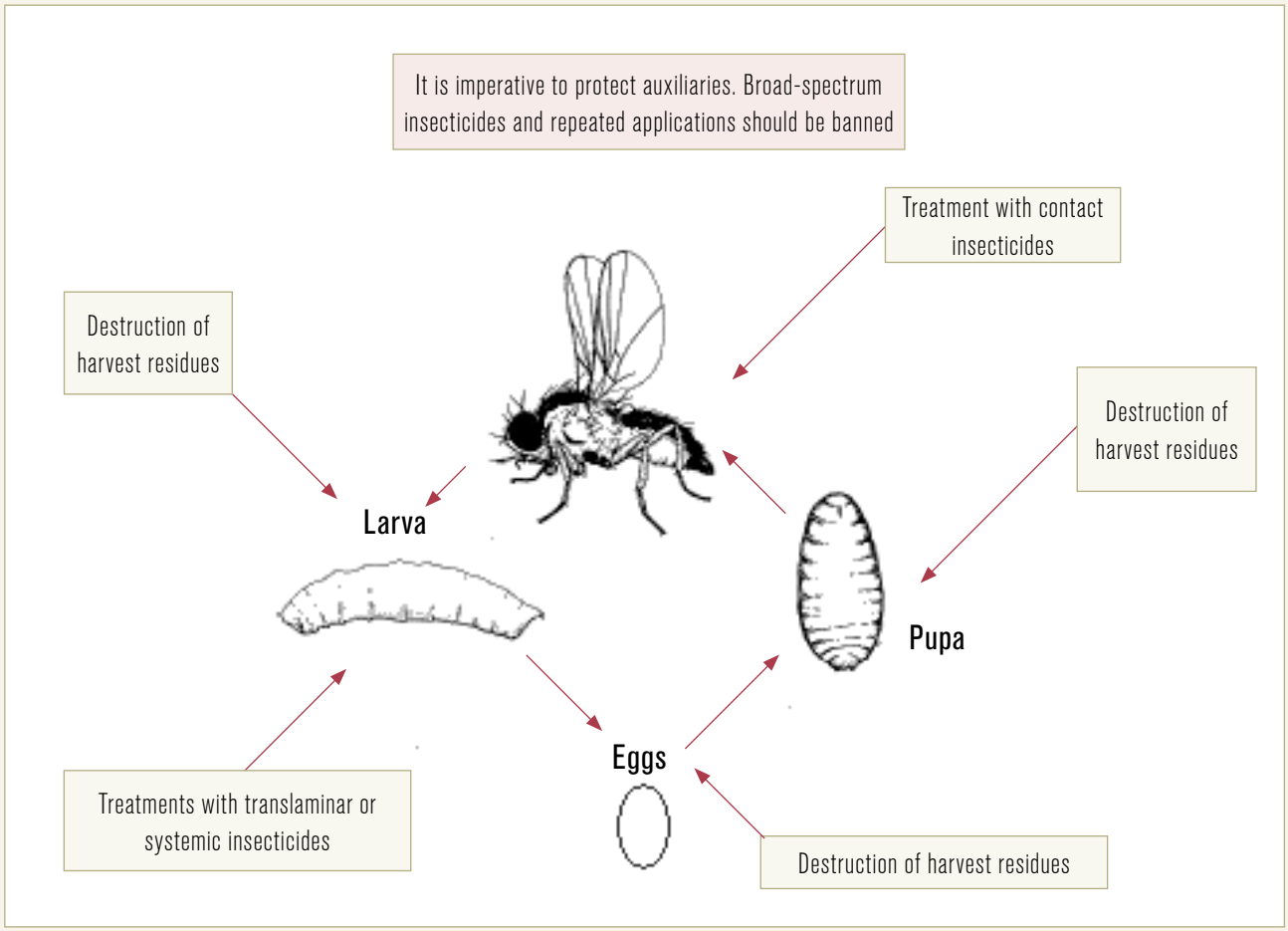
- Removal and destruction of damaged fruit through crushing and deep burial (60-90 cm) or burning.

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



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

Nursery

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.

Field

During the production cycle

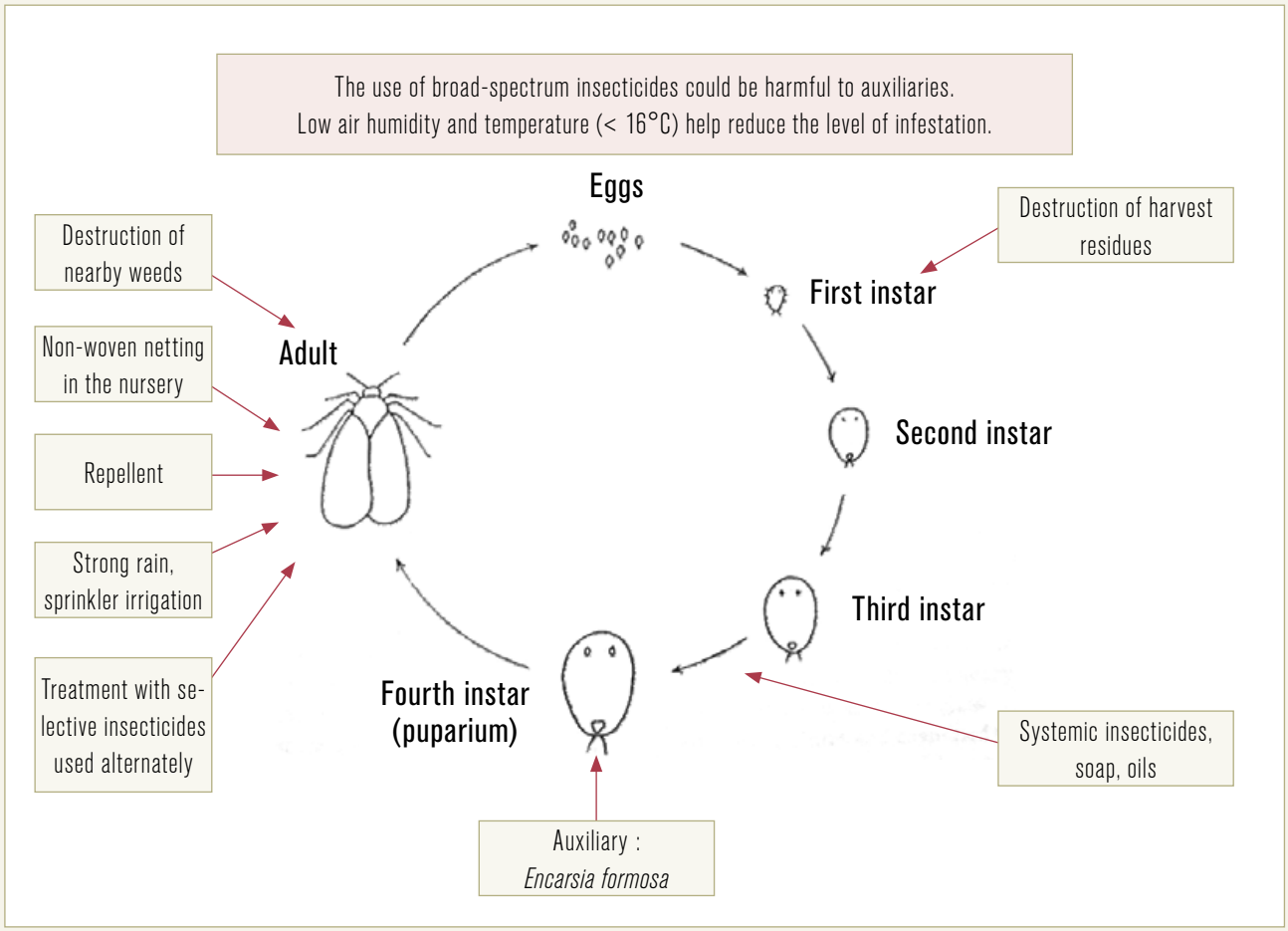
Treatment with selective (to protect auxiliaries), contact (to control the adults), translaminar or systemic insecticides (to kill larvae) used alternately (to limit risks of resistance) in case of serious outbreak.

After the final harvest

Destruction of harvest residues.

WHITEFLY (*Bemisia* sp.)

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

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

Field

<u>During the production cycle:</u>

- 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).

<u>After the final harvest:</u>

Destruction of harvest residues.

Validity and relevance to be checked in local conditions:

- Coloured plastic sheeting used as mulch to limit infestation.

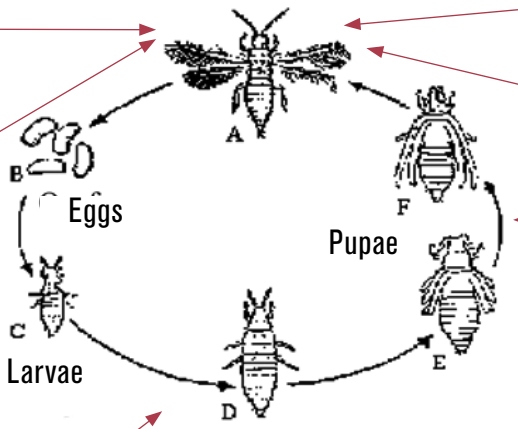
THRIPS *(Thrips* sp., *Ceratothripoides cameroni)*

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*)

Protect seedlings in the nursery with a very fine-mesh insect netting.with a very fine-mesh insect netting.

Mulch with reflective plastic sheeting to keep adults away.



Weed in and around the plot

Leaf insecticide

Till the soil to bring pupae to the surface

Leaf insecticide

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.
- 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.
- Weed in and around the plot.

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.

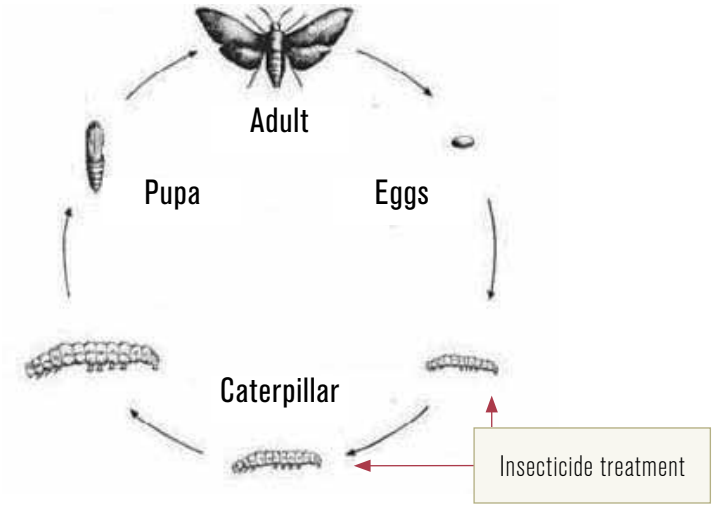
Validity and relevance to be checked in local conditions:

- Mulching with organic matter could also be effective to prevent thrips from attacking melon crops.
- Provide good irrigation, avoid excessive fertilisation and practise good crop rotation.

WEBWORM *(Diaphania (Margaronia) indica)*

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

Field

Before setting

Infestation does not generally occur in the first stages of cultivation.
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.

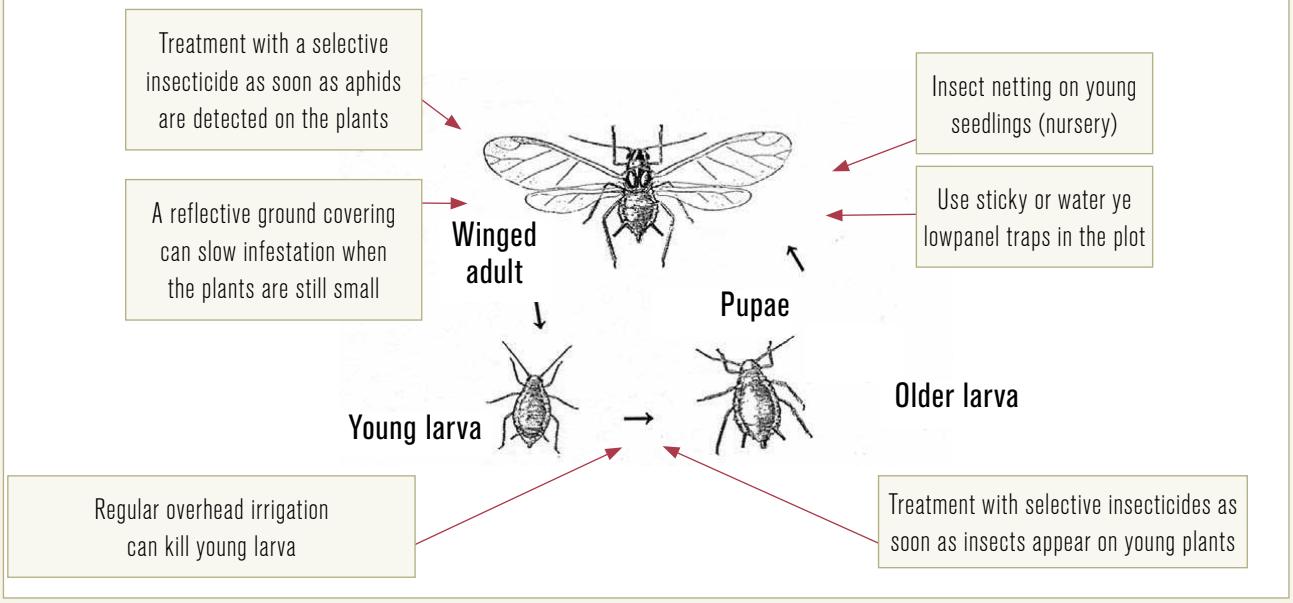
From the first settings

Insecticide treatment as needed to ensure the quality of the fruit.

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.



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

Nursery

- Insect netting with sufficiently fine mesh can prevent the presence of adults on the plant.
- 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

Throughout the production cycle

- Sprinkler irrigation or sustained rain can reduce infestation.
- Use well-balanced fertilisation, because an excess of nitrogen predisposes the plants to attacks by aphids.
- 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.
- Weed the area surrounding the plot to prevent the aphids from proliferating there and then spreading to the crop.
- Certain plants are said to keep aphids away (big marigolds, etc.); they can be planted near the crops.

After the final harvest

- Pull up the plants as soon as they have stopped producing.

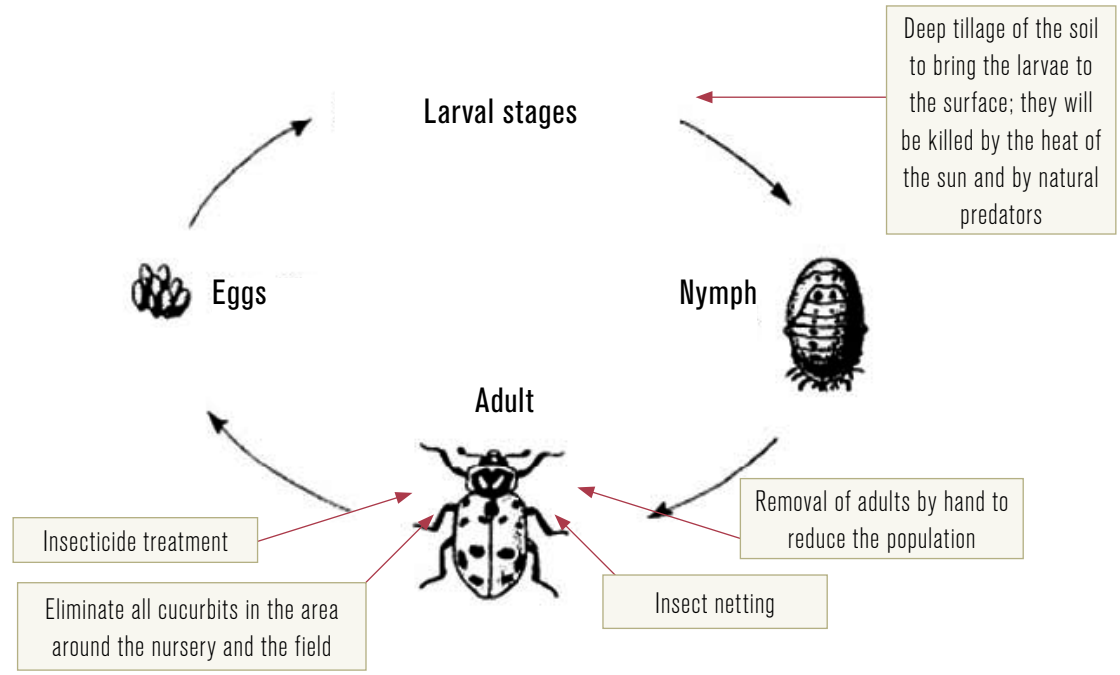
Validity and relevance to be checked in local conditions:

- If the pest is detected, sprinkle the foliage vigorously with water.
- Reflective mulching can slow infestation when the plants are still small.
- Rotate plantings with non-sensitive crops (onions, etc.).

LEAF-EATING BEETLES *(Acalymma vittata, Diabrotica undecimpunctata)*

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

Secondary importance. The use of nurseries is recommended in areas of severe infestation



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

Nursery

- Eliminate all cucurbits in the area around the nursery
- Use physical protection (insect netting, etc.) from emergence to the stage of young plant to provide a protective barrier.

Field

Throughout the production cycle

- Destroy wild cucurbits, which can be important reservoirs of infestation
- Apply insecticides in accordance with intervention thresholds

After the final harvest

- Bury the crop residues deeply. The larvae will not survive deep burial.

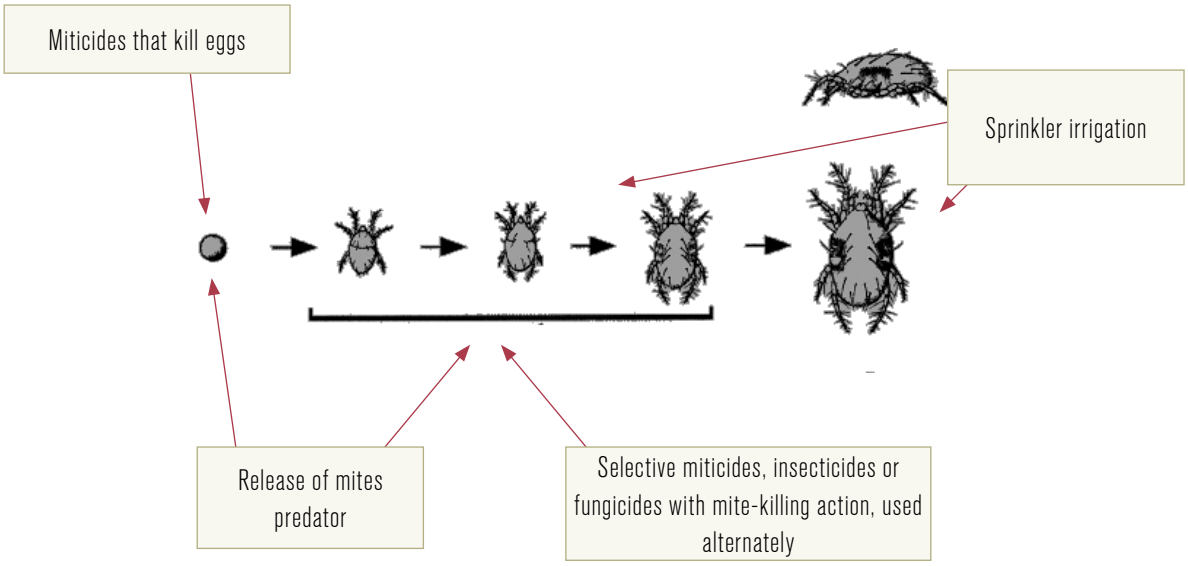
Validity and relevance to be checked in local conditions:

- Planting on mounds rather than on a flat surface so that the soil near the plants will drain rapidly.
- Removal of adults by hand to reduce the population.
- It is preferable to use drip watering so as to limit the damp soil surface, which is favourable to the laying of eggs.
- Plastic and aluminium paper mulching. The reflections keep adults away.
- Fruit must not be left in contact with the ground (e.g. place on pebbles or a trellis).
- Apply wood ash around the base of the plant and on the foliage (rock phosphate can also be used).

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.



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

Nursery

- If necessary, apply products that will eradicate the pest so that plants will be healthy upon leaving the nursery.

Field

Throughout the production cycle

- During the growth phase of the crop in particular, so as to begin harvest with plants showing the least infestation possible, apply insecticides or fungicides (sulphur) with mite-killing action, or preferably specific miticides. For repeated applications, active substances with different modes of action should be alternated to limit resistance.
- Sprinkler irrigation or sustained rain limit populations.
- Predator acarids such as *Phytoseuilus persimilus* can be used to reduce populations. They must be released in the field as soon as the red spider mites are detected.

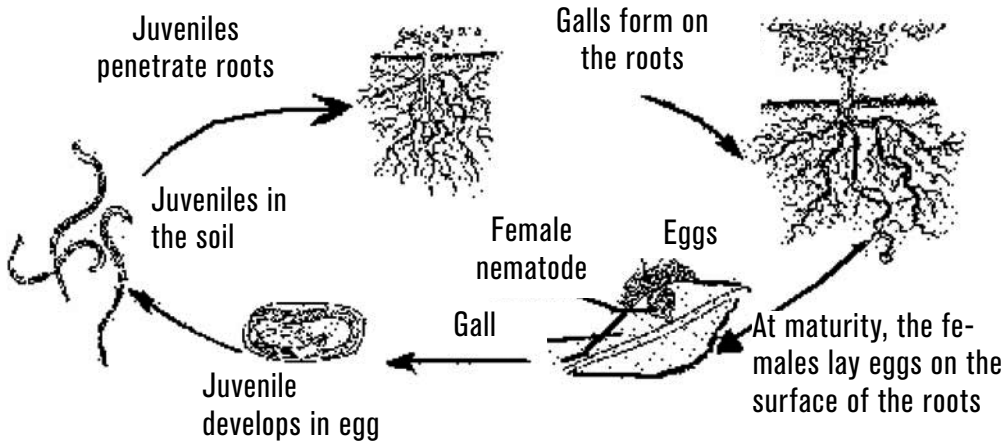
ROOT-KNOT NEMATODE (*Meloidogyne* spp.)

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 de-pressive 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 melon 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 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

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 melon 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 melon 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 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

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.

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 melon 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 ordert 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 on the melon 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
Transport of spores	Avoid walking through the plots when the plants are wet.							X	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

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	Choose a plot exposed to sunlight all day long and with well-drained soil.		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 on the melon plant	Apply specific and systemic fungicides by watering around the base of the plant (possibly using a drip irrigation system).							X			
Production of spores	Pull up and burn diseased plants.							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

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 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								
	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 melon plant	Apply specific and systemic fungicides by watering around the base of the plant (possibly using a drip irrigation system).							X	X	X	X
Production of spores	Pull up and burn diseased plants.										X
Conservation in the soil	Deep tillage is necessary to bury the harvest residues so that they decompose completely.					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

CUCUMBER MOSAIC (CMV)

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, which is very frequent on melon, is 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
Germination on 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 on the melon 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

Suppliers	Varieties	Resistance or tolerance				
		Aphids	Leaf-eating beetles	Downy mildew	Fusarium	Powdery mildew
Associated Seed Growers, (USA)	Texas Resistant No.1	X		X		
Baumaux (France)	F1 Bastion, F1 Tucan , F1 Fidji, F1, Brennus, F1 Galick, F1 Cyrano, F1, Figaro, F1 Sugar, F1 Zecchino				X	X
Baumaux (France)	F1 Orus, F1 Pepito				X	
Gautier (France)	Galoubet, Pallium				X	X
Georgia Expt. Sta. Experiment (USA)	Georgia 47	X		X		X
Goldsmith	Nova					X
Harris Moran Seeds Co	Twilight				X	X
Heirloom Vegetable Seeds (USA)	Planter's Jumbo, Tam Uvalde			X		X
La Ferme de Sainte-Marthe	Chilton			X		X
Petoseed	Laredo					X
Sakata et Takii (Japon)	Amur et Bonus				X	X
SS Ivanoff, Mississipi Agric. Expt. Sta., State College (USA)	Homegarden			X		X
Sunseeds, (USA)	Mainpack					X
Sunseeds, (USA)	Ironhorse	X		X	X	X
Technisem (France)	F1 Ananas et F1 Galia					X
Technisem (France)	Perlita			X		X
Tézier (France)	Alpha, Delta, Omega				X	X
Tézier (France)	Mab hybride F1				X	
USDA (Charleston, South Carolina, USA)	Mainstream		X	X		X
Vilmorin (France)	Awwal F1, Solaris F1 et Diabolo F1				X	X
Vilmorin (France)	Sari F1					X
Vilmorin (France)	Verdol F1,				X	
Vilmorin (France)	Zagara F1	X			X	X
Yates (Autralie)	Dixie					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. Broadspectrum insecticides should therefore be avoided as much as possible. The use of selective active substances, when available, is preferred as a means of protecting natural enemies. Explanations of the importance of natural enemies and ways of encouraging their presence can be found in documents especially dedicated to this matter.

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

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. General observation techniques are described in the COLEACP/PIP training. Certain information is given below on the thresholds whose validity and relevance are to be checked in local conditions.

Leafminer fly (*Liriomyza* spp.)

A threshold of three mines per leaf is recommended in the West Indies.

Whitefly (*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* (*Margaronia*) *indica*)

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 on melon and watermelon. On squash, aphids are generally found on the older leaves or flowers. 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.
Plants must be treated as soon as the first beetles are detected.

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

For each pest or disease, proposals of the strategy for the use of Plant Protection Products (PPP) are indicated below.
A list of active substances is suggested for each pest or disease. When available, the critical GAP is also given.
The PHIs (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 doses, frequency of application and number of applications, last application before harvest not respecting the recommended pre-harvest interval) can result in residues in excess of the MRL in force. These GAPs does not represent a treatment calendar to be applied as such. In practice, the frequency of treatments must take account locally of the severity of attacks and the real risks of damage

Some GAP (highlighted with yellow boxes in the tables thereafter) was tested by PIP in melons in 2009/10 under tropical conditions in Senegal.
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 there are very few PPP registerd on this crop in ACP countries and 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.

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.

Commercial soap-based PPPs (to control aphids, spider mites, whitefly, etc.) also exist and are not listed in the following tables because they pose no problems in terms of residues.

Others substances act as a physical trap on some small insects, nematodes and fungus and are not considered like conventional Plant Protection Products. For instance propylene glycol alginate can trap aphids, white flies and mites as well as nematodes and powdery mildews when applied correctly. This substance as no pesticide 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 beetle - *Aulacophora africana* and *Monolepta* sp.

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

Melon 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 pollenising insects. The underside of leaves must be carefully treated to reach the larvae found there.

Leaf-eating beetles - *Acalymma vittata* ou *Diabrotica undecimpunctata*

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

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
	Group 3 – Pyrethroids (sodium channel modulators)												
Alpha-cypermethrin	10	/	/	7	/	/							
Bifenthrin	40	2	/	3	/	/							
Deltamethrin	12.5	2	7	3	3	3							
Lambda-cyhalothrin	20	2	12	3	3	3							
Cypermethrin	40 - 50	/	/	/	/	/							

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

/ elements of the recommended GAP not available

Cucurbit fly - *Dacus* 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 (8-10 cm in diameter). To improve their effectiveness, bait (protein hydrolisate, sugar water) can be added to the insecticide mixtures, which will be sprayed in a steady stream on nurse crops near the melon crop. Insecticides are applied to the crop itself from the start of flowering or setting at intervals of one week in cases of severe infestation. They are continued until the majority of the fruit has made it through the sensitive stage of 8 to 10 cm in diameter. It is essential to use insecticides that are not toxic to pollenising insects. With furrow irrigation we avoid a wash-off of the products on foliage and prolong the effectiveness of treatment.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 3 – Pyrethroids													
Bifenthrin	50	2	/	7	/	/					■		
Deltamethrin	12.5	/	7	3	3	3					■	■	
Lambda-cyhalothrin	12,5	2	7	3	3	3					■	■	
Group 1 – Organophosphates and carbamates													
Malathion	/	/	/	3	3	3							
Group 5 – Spynosines													
Spinosad	144	4	7	3	3	3					■	■	
Spinosad used to control fruit fly should be 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 for melon.													

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

/ elements of the recommended GAP not available

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	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 17													
Cyromazine	300	3	7	10	10	>21							
Group 6 - Avermectins													
Abamectin	9	4	7	3	/	/							

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

/ elements of the recommended GAP not available

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 brupofezine 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 pollenising insects.

Active substance	Recommended GAP*						Proposed application period						
				Pre-harvest interval (days)									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	CODEX MRL	LOQ	Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
Group 3 – Pyrethroids													
Bifenthrin	50	2	/	7	/	/					■		
Ethofenprox	/	/	/	/	/	/							
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists													
Acetamiprid	30	2	7	14	/	14			■	■	■		
Imidacloprid	100	2	7	3	3	3							
Thiamethoxam	100	2	7	3	3	3			■	■	■		
Group 16													
Buprofezin	/	/	/	/	/	/							
Group 2 – Organochlorins and fiproles													
Endosulfan	/	/	/	/	/	/							
Group 1 – Organophosphates and carbamates													
Methomyl	300	/	/	7	/	/			■	■	■		
Group 9													
Pymetrozine	200	3	7	3	/	/			■	■	■		
Group 21													
Rotenone	200	/	/	/	/	/							

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL, the Codex MRL or the LOQ (0 residues). (see part 6 of this guide).
/ elements of the recommended GAP not available

Thrips - *Ceratothripoïdes cameroni, Frankliniella occidentalis, 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 following period requires the use of insecticides that are not toxic to pollenising insects.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 6 – Avermectins													
Abamectin	22.5	4	7	3	/	/			■	■	■	■	
Group 3 – Pyrethroids													
Acetamiprid	71.25	/	/	14	/	14			■	■	■	■	
Deltamethrin	12.5	2	7	3	3	3					■	■	
Bifenthrin	15	2	/	3	/	/					■	■	
Group 1 – Organophosphates and carbamates													
Formetanate	500	2	21	7	/	/			■	■	■		
Methomyl	200	/	/	7	/	/			■	■	■		
Group 4 – Nicotinic acetylcholine receptor agonists/antagonists													
Imidacloprid	100	2	7	3	3	3							
Group 21													
Rotenone	200	/	/	/	/	/							
Group 5 – Spynosines													
Spinosad	144	4	7	3	3	3			■	■	■	■	

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

/ elements of the recommended GAP not available

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

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

Active substance	Recommended GAP*						Proposed application period						
				Pre-harvest interval (days)									
	Dosage	Maximum number applications	Minimum interval between applications (days)	EU MRL	CODEX MRL	LOQ	Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
Group 3 – Pyrethroids													
Alpha-cypermethrin	10	1	/	7	/	/			■	■	■		
Bifenthrin	10	2	/	3	/	/			■	■	■		
Deltamethrin	12,5	2	7	3	3	3			■	■	■	■	
Esfenvalerate	12.5	/	/	/	/	/							
Lambda-cyhalothrin	20	2	12	3	3	3			■	■	■	■	
Group 1 – Organophosphates and carbamates													
Carbaryl	765	1	/	3	/	/			■	■	■	■	
Group 5 – Spynosines													
Spinosad	144	4	7	3	3	3			■	■	■	■	

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL, the Codex MRL or the LOQ (0 residues). (see part 6 of this guide).
/ elements of the recommended GAP not available

Aphids

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 (pyrimicarb, 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 pollenising insects.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 9													
Pymetrozine	100	3	7	3	/	/			■	■	■	■	
Group 1 - Organophosphates and carbamates													
Pirimicarb	50	2	7	3	/	/			■	■	■	■	
Methomyl	300	/	/	7	/	/					■		
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists													
Imidacloprid	100	2	7	3	3	3							
Thiamethoxam	100	2	7	3	3	3					■	■	
Acetamiprid	30	2	7	14	/	14					■	■	
Thiacloprid	96	2	/	3	/	/					■	■	
Group 3 – Pyrethroids													
Bifenthrin	15	2	/	3	/	/					■	■	
Lambda-cyhalothrin	12,5	2	7	3	3	3					■	■	
Tau-fluvalinate	48	/	/	3	/	/					■	■	

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

/ elements of the recommended GAP not available

Red spider mite - *Tetranychus* sp.

Strategy: Red spider mites are polyphagous pests that are harmful at every stage of their development (larvae, pupae and adults). Selective acaricides should be used, with an alternation to limit risks of resistance and to minimise the negative impact on auxiliaries, including predator acarids (phytoseidae). 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 fungicide (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 (dust-covered plants beside paths), it is sometimes possible and useful to concentrate applications on the infested areas.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 6 – Avermectins													
Abamectin	9	4	7	3	/	/			■	■	■	■	
Group 3 – Pyrethroids													
Acrinathrin	60	/	/	3	/	/			■	■	■	■	
Bifenthrin	60	2	/	7	/	/					■		
Group 10													
Clofentezine	200	/	/	3	/	/					■	■	
Hexythiazox	50	/	/	3	/	/					■	■	
Group 12													
Cyhexatin	300	/	/	/	/	/				■	■		
Fenbutatin oxide	495	2	/	3	/	/				■	■	■	
Group UN – mode of action unknown													
Dicofol	500	/	/	15	/	/				■			
Not classified													
Sulphur	3600	7	7	3	/	/					■	■	
Group 21													
Tebufenpyrad	/	/	/	/	/	/							

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL, the Codex MRL or the LOQ (0 residues). (see part 6 of this guide).
/ elements of the recommended GAP not available

Root-knot nematodes - *Meloidogyne* spp

Strategy: In case of absolute necessity, nematicides (ethopfophos, cadusaphos, etc.), which are often expensive and toxic, can be applied at sowing, on the strips or in pockets, avoiding generalised application.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 1 – Organophosphates and carbamates													
Pirimicarb	/	/	/	At planting	/	/							
Methomyl	/	/	/	At planting	/	/							

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL, the Codex MRL or the LOQ (0 residues). (see part 6 of this guide).
/ elements of the recommended GAP not available

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.

Powdery mildew - *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 pyrimidine should be used. Only authorized products should be used, in the recommended doses and observing the pre-harvest interval. Treatments must be repeated at intervals of seven to 14 days depending on the product and the climate conditions. 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).

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 11 – QoI fungicides													
Azoxystrobin	200	3	10	3	/	/					■	■	
Kresoxim-methyl	40	2	/	3	/	/					■	■	
Pyraclostrobin	100	3	/	3	/	/					■	■	
Trifloxystrobin	/	/	/	/	/	/							
Boscalid	80	2	/	3	/	/					■	■	
Group 8 – hydroxy-(2-amino-)pyrimidines													
Bupirimate	500	/	/	7	/	/					■		
Group 3 – DMI - fungicides													
Myclobutanil	75	3	10	3	10	10					■	■	
Penconazole	50	4	7	3	/	/					■	■	
Tetraconazole	/	/	/	/	/	/							
Triadimenol	/	/	/	/	/	/							
Triforine	/	/	/	/	/	/							
Imazalil	56	/	/	3	/	/					■	■	
Group M – Multisite activity													
Sulphur	3600	7	7	3	/	/					■	■	
Group 1 – MBC fungicides													
Thiophanate-methyl	360	3	10	3	10	10							

* The elements of the recommended GAP shown here allow to comply with the harmonised European MRL, the Codex MRL or the LOQ (0 residues). (see part 6 of this guide).
/ elements of the recommended GAP not available

Downy mildew - *Pseudoperonospora cubensis*

Strategy: In the case of intensive cultivation in climate conditions favourable to the disease, fungicide treatments will be applied starting in the nursery, 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.) or chlorothalonil 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 triazole (myclobutanil) provide good control of the disease. They should be used only every 10 days because they are more persistent. The same active substance should not be used more than twice on a plot.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 11 – QoI fungicides													
Azoxystrobin	200	3	10	3	/	/							
Famoxadone	1125	3	/	3	/	/							
Group M – Multisite activity													
Chlorothalonil	1500	4	7	3	3	>21							
Copper	/	/	/	5	/	/							
Mancozeb	1600	4	7	3	3	>21							
Maneb	1600	/	/	3	/	/							
Propineb	2000	/	7	3	/	/							
Tolyfluanid	1250	3	/	14	/	/							
Group 10 – N-phenyl carbamates													
Diethofencarb	/	/	/	/	/	/							
Group 33 – Phosphonates													
Fosethyl-Al	3200	/	/	3	/	/							
Group U – Risk of resistance unknown													
Iprovalicarb	/	/	/	/	/	/							
Group 27 – Cyanoacetamide-oximes													
Cymoxanil	150	3	/	3	/	/							
Group 4 – PhenylAmide fungicides													
Metalaxyl-M	94	3	/	3	/	/							
Group 28 – Carbamates													
Propamocarb-HCl	1125	2	7	3	/	/							

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

/ elements of the recommended GAP not available

Collar rot - *Pythium aphanidermatum*

Strategy: Apply preferably as a preventive treatment in the nursery substratum or at the foot of plants in the field.

Active substance	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Group 24 - Carbamates													
Propamocarb HCL	See below			3	/	/							

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 controlPythium 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.

Group 4 - PhenylAmide fungicides													
Metalaxyl-M	/	/	/	/	/	/							

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	Recommended GAP*						Proposed application period						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days)			Preparation of soil	Sowing	Nursery	Transplant to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak to final harvest
				EU MRL	CODEX MRL	LOQ							
Copper	800	/	/	5	/	/							

CMV (*cucumber mosaic virus*)

Strategy: Because viral diseases are transmitted primarily by insects (aphids), the vectors of viruses need to be controlled (see controlling aphids) on young plants.

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

/ elements of the recommended GAP not available

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

Active substance	Commercial product	Manufacturer	Source		
			Year	Country	Type
Chlorothalonil	Bravo 500 SC	Syngenta	2010	Senegal	PIP trial
Cyromazine	Trigard 75 WP	Syngenta	2010	Senegal	PIP trial
Deltamethrin	DECIS 25 EC	Bayer CropScience	2010	Senegal	PIP trial
Imidacloprid	Confidor 200 SL	Bayer CropScience	2010	Senegal	PIP trial
Lambda-Cyhalothrin	Karate 5 CS	Syngenta	2010	Senegal	PIP trial
Mancozeb	Dithane M 45	Dow AgroSciences	2010	Senegal	PIP trial
Myclobutanil	Systhane 240 EC	Dow AgroSciences	2010	Senegal	PIP trial
Spinosad	Laser 480 SC	Dow AgroSciences	2010	Senegal	PIP trial
Thiamethoxam	Actara 25 WG	Syngenta	2010	Senegal	PIP trial
Thiophanate-methyl	Topsin M 50 SC	Bayer CropScience	2010	Senegal	PIP trial

5 – Existing registrations in ACP countries

For the ACP countries treated in this guide, there are practically no registered plant protection products for the use on melon.

For Senegal and Mauritania, the registration issued by the Sahel Pesticides Commitee (CSP) apply. The only existing registration for use on melon is that of a commercial product based on lambda-cyhalothrin & acetamiprid against caterpillars, aphids and white flies in horticultural crops.

For the Dominican Republic, we currently have no information on existing registrations.

6 – Regulations and pesticide residues

Status of the active substances in Regulation 1107/2009 (Former Directive 91/414); European and Codex MRLs in September 2011.
Caution: The information contained in this table is subject to change by future directives of the Commission of the European Communities and Codex.

Active substance	Active substance		Codex MRL *
	Status Reg. 1107/2009	EU MRL	
Abamectin	Approved	0.01**	0.01
Acetamiprid	Approved	0.01**	/
Acrinathrin	Not approved	0.1	/
Alpha-cypermethrin	Approved	0.2	0.07 (cucurbits)
Azoxystrobin	Approved	1	1 (cucurbits)
Bacillus thuringiensis	Approved	0	/
Bifenthrin	Not approved	0.05**	/
Boscalid	Approved	3	/
Bupirimate	Approved	0.2	/
Buprofezin	Approved	1	/
Carbaryl	Not approved	0.05**	/
Chlorothalonil	Approved	1	2
Clofentezine	Approved	0.1	0.1
Copper	Approved	5	/
Cyhexatin	Approved	0.05**	/
Cymoxanil	Approved	0.1	/
Cypermethrin	Approved	0.2	/
Cyromazine	Approved	0.3	0.5
Deltamethrin	Approved	0.2	0.2 (cucurbits)
Dicofol	Not approved	0.5	0.2
Diethofencarb	Approved	0.5	/
Endosulfan	Not approved	0.05**	2
Esfenvalerate	Approved	0.02**	/
Ethoprophos	Approved	0.02**	/

* sum of fosethyl + phosphorous acid and their salts , expressed in fosethyl

Active substance	Active substance		
	Status DIR 91/414	European MRL	
Etofenprox	Approved	0.5	/
Famoxadone	Approved	0.3	/
Fenbutatin oxide	Approved	0.05**	/
Formetanate	Approved	0.05**	/
Fosethyl-Al	Approved	75	/
Hexythiazox	Approved	0.5	/
Imazalil	Approved	2.0	2
Imidacloprid	Approved	0.5	0.2
Iprovalicarb	Approved	0.2	/
Kresoxim-methyl	Approved	0.2	/
Lambda-cyhalothrin	Approved	0.05	0.05 (cucurbits)
Malathion	Approved	0.02**	/
Mancozeb	Approved	1	0.5
Maneb	Approved	1	0.5
Metalaxyl	Approved	0.2	0.2
Methomyl	Approved	0.02**	0.1 (cucurbits)
Myclobutanil	Approved	0.2	/
Oxamyl	Approved	0.01**	2
Penconazole	Approved	0.1	0.1
Propamocarb HCl	Approved	5	5 (cucurbits)
Propineb	Approved	1	0.5
Pymetrozine	Approved	0.2	/
Pyraclostrobin	Approved	0.5	/
Pirimicarbe	Approved	1	0.2
Rotenone	Not approved	0.01**	/
Spinosad	Approved	1	0.2 (cucurbits)
Sulphur	Approved	Not required	/
Tau-fluvalinate	Approved	0.05	/
Tebufenpyrad	Approved	0.5	/
Tetraconazole	Approved	0.05	/
Thiacloprid	Approved	0.2	0.2
Thiamethoxam	Approved	0.2	/
Thiophanate-methyl	Approved	0.3	/
Tolyfluanid	Approved	0.3	/
Triadimenol	Approved	0.2	0.2 (cucurbits)
Trifloxystrobin	Approved	0.3	0.3 (cucurbits)
Triforine	Not approved	0.05**	0.5 (cucurbits)

* If there is no Codex MRL fixed on melons the LOQ should be used, in case the a.s. can be found in the Codex list; "/" means no data in the Codex data base.
** MRL indicates a lower limit of analytical determination (LOQ)

Note on the status of active substances in EU

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

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

Note on MRLs:

The quantities of pesticide residues found in food must be safe for consumers and remain as low as possible.

The maximum residue limit (MRL) is the maximum concentration of pesticide residue legally permitted in or on food or feed.

MRLs in the EU

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

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

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

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

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

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

How are MRLs applied and monitored in EU?

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

MRLs in ACP countries – Codex

The Codex Alimentarius Commission was established in 1961 by the Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) with the objective to develop an international food code and food standards. Membership of the Codex Alimentarius Commission is open to all Member Nations and Associate Members of FAO and WHO. More than 180 countries and the European Community are members of the Codex Alimentarius Commission.

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

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

References, Websites and Useful Documents

1. References and useful documents

A.D.A.Bio (2001) Fiche technique en agriculture biologique : courge et potiron.

APPERT JEAN, DEUSE J. (1982) Les ravageurs des cultures vivrières et maraîchères sous les tropiques, Techniques agricoles et productions tropicales. 420 p.

BAILLY R. (1980) Guide pratique de défense des cultures. Reconnaissance des ennemis, notions de protection des cultures. ACTA, 418 p.

BLANCARD D. LECOQ H. PITRAT M. (1991) Maladies des curcubitacées - Observer ; Identifier ; Lutter INRA. ; 301 p.

BOURDOUXHE, L. (1983) Dynamique des populations de quelques ravageurs importants des cultures maraîchères du Sénégal. Agronomie Tropicale 38 (2): 132-149.

BOVEY R. (1979) La défense des plantes cultivées. Traité pratique de phytopathologie et de zoologie agricole. Ed. Payot Lausanne, 864 p.

COLLINGWOOD. E.F., BOURDOUXHE L. et DEFRANCQ M. (1981) Les principaux ennemis des cultures maraîchères au Sénégal. Centre pour le développement de l'horticulture, Dakar. 95 p.

COLLINGWOOD. E.F., BOURDOUXHE L. et D'HONDT M. (1988) Incidence des ravageurs et maladies; systèmes de contrôle.

In: Production de légumes dans les conditions arides et semi-arides d'Afrique tropicale. Etudes FAO Production végétale et Protection des Plantes 89: 155-207.

CTA – PAN (1993) Pesticides et agriculture tropicale, dangers et alternatives. 281 p.

DECLERT CLAUDE (1990) Manuel de phytopathologie maraîchère tropicale. Cultures de Côte d'Ivoire. ORSTOM. 333 p.

DEUSE J. et LAVABRE E.M. (1979) Le désherbage des cultures sous les tropiques, Techniques agricoles et productions tropicales. 312 p.

FABRE F., RYCKEWAERT P., DUYCK P.F., CHIROLEU F. and DUILICI S. (2003) Comparison of the efficacy of different food attractants and their concentration for melon fly. J. Econ. Entomol. 96 (1): 231-238

FRÖHLICH G. & RODEWALD W. (1970) Pests and diseases of tropical crops and their control. Pergamon press, 342 p.

HILL, D. (1975). Agricultural insect pests of the tropics and their control. Cambridge Univ. Press, Cambridge. 516 p.

JONES & JONES (1966) Pests of Field crops. Arnold, 386 p.

MESSIAEN C-M. et LAFON R. (1970) Les maladies des plantes maraîchères, INRA, 419 p.

MESSIAEN C-M. (1974) Le potager tropical 1 - Généralités. 196 p.

MESSIAEN C-M. (1974) Le potager tropical 2 – Cultures spéciales. 393 p.

RAEMAECKERS ROMAIN H. (2001) Agriculture en Afrique tropicale, DGCI, 1634 p.

SCHMUTTERER, H. (1969): Pests of Crops in Northeast and Central Africa. Gustav Fischer Verlag, Stuttgart, 296 pp.

YORK A. (1982) Pest of cucbit crops : Marrow, pumpkin, squash, melon and cucumber, In : Mc Kinlay, Vegetable crop pests P. 139-161

2. Useful Websites

Melon

http://www.horticom.com/tem_aut/fitopat/virosis.html
http://www.infoagro.com/frutas/frutas_tradicionales/melon.htm

Cucurbits

http://www.extento.hawaii.edu/kbase/reports/recommendations/cucurbit.asp
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)

Diseases and pests

General
http://plant-disease.ippc.orst.edu/ (Plant disease control – Oregon state university)
http://www.ceris.purdue.edu/napis/pests/index.html
http://vegetablemdonline.ppath.cornell.edu/PhotoPages/PhotoGallery.htm#Cucurbit (department of plant pathology, Cornell university, NY)
http://www.inra.fr/Internet/Produits/HYPPZ/ravageur.htm
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?LISTVAR=Recherche_Parasites2
http://ipm.ncsu.edu/AG295/html/Plate_Index.html
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)

Fruit fly
http://fruit-flies.netfirms.com/french/2f-ceratitis.htm
http://portal.areu.mu/modules.php?name=News&file=article&sid=63 (Agricultural research and extension unit)

Thrips
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7429.html
http://www.nysaes.cornell.edu/ent/hortcrops/english/thrips.html

Seed

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

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