PIP

GUIDE TO GOOD CROP PROTECTION PRACTICES

FOR EGGPLANTS (*SOLANUM MELONGENA, SOLANUM AETHIOPICUM, SOLANUM MACROCARPON*)

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".

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PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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Note

The Guide to Good Plant Protection Practices details all plant protection practices regarding the production of the fruit or vegetables in question and recommends primarily the active substances supported by pesticides manufacturers in the framework of EU Directive 91/414, which must comply with European standards for pesticide residues. Currently, these active substances have not been tested by PIP in ACP countries to check their conformity with European MRLs. The information given on the active substances suggested is therefore changeable and will be adapted on an ongoing basis in accordance with the new information collected by PIP.

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

The PIP's crop protocols and guides to good phytosanitary practices are regularly updated. For further information, see the PIP website www.coleacp.org/pip

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Table of contents

1. Main pests and diseases

1.1. Importance and impact on yield and quality

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 fruits 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, number of fruits per plant reduced, 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	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Cutworms - *Agrotis* spp.						
+	Leaves and/or stem are eaten by caterpillars		Plants can be cut off when young so reducing density and harvest	Damage on older plants will affect the growth, but not cause death.		
Thrips -*Thrips palmi* QO and *Frankliniella occidentalis* QO						
+++	Eaten by adults and larvae		Heavy infestation can kill the plant	Significant reduction if growth is slowed by severe attacks on young plants.		Both nymphs and adults leave scars, deformities. The transmission of viruses (eg. TSWV) contribute to a significant loss. Often 100% loss in quality if fruit is affected.
Epilachna beetle - *Epilachna* spp.						
+++	Eaten by adults and larvae			Feeding on the leaves can significantly reduce the plants photosynthetic potential.		Superficial damage on the fruit reduces exportable quality.
Flea beetle - *Epitrix cumumeris* and *E.tuneris* QO						
++	Eaten by adults			Heavy feeding on the leaves can significantly reduce the plants photosynthetic potential of young plants		

INSECTS (continued)						
Extent	Organs attacked		Types of loss			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
White flies - *Bemisia tabaci* QO ; *Trialeurodes vaporariorum*						
+++	Bitten into by adults and larvae			Reduced if photosynthesis is significantly slowed due to the presence of sooty mould that develops on the honeydew secreted by larvae		Honeydew depreciates market value of fruit
Leafminer fly - *Liriomyza trifolii* QO, *L.huidobrensis*, *L.bryoniae*						
++	Bitten into by adults and mined by larvae			Reduced if photosynthesis is significantly slowed due to extensive mining		
Aphids - *Aphis gossypii*						
++	Bitten into by adults and larvae			High infestations lead to weakening of plants and distorted leaves, reducing yield and quality.		Sooty mould deposits also reduce fruit quality
Bollworm - *Helicoverpa armigera* QO; *Daraba laisalis*						
+++	Eaten by larvae					Hole and rot in the fruits
Jassids - *Amrasca* spp.						
++	Bitten into by adults and larvae		Heavy feeding can reduce fruit set, result in deformed fruit and can kill shoots and buds.			

MITES						
Extent	Organs attacked		Types of loss			
	Leaves	Fruits	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		Plants can be killed rapidly if infestations are high.	Reduced if attack is severe		

FUNGI						
Extent	Organs attacked		Types of loss			
	Stem	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Damping off - *Pythium* sp, *Rhizoctonia* sp., *Phytophthora* sp.						
+	Development of mycelium inside the stem		Loss of young plants through damping-off			
Verticillium wilt - *Verticillium* sp.						
++	Development of mycelium inside the stem		Seedlings are very susceptible considerable losses can result after transplanting.			

FUNGI (continued)						
Extent	Organs attacked		Types of loss			
	Leaves	Fruits	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Early blight - *Alternaria solani*						
+	Presence of the fungus on upper surfaces			Reduced if photosynthesis is significantly slowed due to the presence of the fungus		
Late blight - *Phytophthora capsici* or *Phytophthora parasitica*						
+++	Presence of the fungus on leaves and stems	Development of mycelium in the fruit	Premature death of plants	Reduced if photosynthesis is significantly slowed due to the presence of the fungus		Fruit rot
Powdery mildew - *Leveillula taurica*						
+++	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	Severe infections can result in small fruit and low quality.	

BACTERIA						
Extent	Organs attacked		Types of loss			
	Stems	Leaves	Number of plants	Number of fruits/plant	Size of fruit	Quality of fruit at maturity
Bacterial wilt - *Ralstonia solanacearum* QO						
Before the discovery of resistant varieties, the fungus could cause a total loss of the crop.						
++	Mycelium enter in the rots and develop in the stem		Loss of plants at all stages			

NEMATODES					
Extent	Organs attacked	Type de perte			
	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 vascular fungi. 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		

1.2. Identification and damage

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

INSECTS

Cutworms – *Agrotis* spp.

The pest is solitary in nature. Worms feed on foliage and fruit. Transplants are cut off close to soil level, killing plants. Plants may also be attacked when older, causing stem distortions at soil level.

Larvae

Thrips – *Thrips palmi, Frankiniella occidentalis*

Found in pockets, cracks or crevices on host plants. Silvery feeding scars appear on leaf surface, especially alongside the midrib and veins. The leaves and terminal shoots of severely infested plants are silvered or bronzed. Fruit becomes scared and deformed. Thrips are vectors of the viruses such as TSWV (Tomato spotted wilt virus), causing bronzing, stunting and mosaic necrotic spots and concentric rings. *Thrips palm*i is currently not recorded in Mainland Africa.

Damage to aubergine fruit

Epilachna beetles – *Epilachna dregi*

Adult and larvae feed on leaves and fruit. Their feeding results in skeletonised patches, as a result of feeding on the parenchyma and lower epidermis between leaf veins, which dry out. Leaves may be completely stripped to the mid-veins.

Adult Larva

Flea beetle - *Epitrix cumumeris* and *E.tuneris*

The adults cut characteristic shot like holes (1.0 to 1.5 mm diameter) in leaves. The larvae inhabit the soil around the roots. They have been associated with pathogens such as *Verticillium dahliae*, *Fusarium coeruleum* and *Thanatephoris cucumeris*.

THoles in a leaf

Whiteflies - *Bemisia tabaci, Trialeurodes vaporariorum*

Adults and nymphs suck the leaf tissue affecting the physiology of the plant. This results in stunted growth and affect the development of fruit. Secretion of honeydew makes the leaves and fruit sticky and sooty mould (*Cladosprium*) develops disrupting photosynthesis and transpiration.

Adults on the underside of a leaf

Leafminer - *Liriomyza trifolii, L. huidobrensis, L. bryonia*

Feeding punctures appear as white/yellow speckles between 0.13 and 0.15 mm in diameter. Mines are usually white with dampened black and dried brown areas, tightly coiled or irregular in shape, increasing in size as the larva matures.

Aphids - *Aphis gossypii*

Aphid colonies cluster around growing points of plants. Nymphs and adults suck sap from young shoots and buds. Feeding causes distortion, curling and leaf drop. Fruits become misshapen. Secretion of honeydew supports the growth of sooty mould. The presence of individual winged aphids is an indication of new colonies about to be established.

Young plant distorted by aphis

Sooty mould on a young fruit

Aphis and larva of predators (*Scymnus* on the left, *Syrphid* on the right)

Bollworm - *Helicoverpa armigera* or *Daraba laisalis*

Bollowrms are highly mobile and polyphagous. Larva feed on buds, chew holes in leaves, and burrow into fruit (leaving a round hole). During fruiting, eggs are laid on the fruit and larva penetrate soon after hatching.

Caterpillar in a fruit

Jassids - *Amrasca* spp.

Jassids feed by sucking sap from the leaves. The infested leaves curl upwards along the margin. The leaves result in small irregular yellow patches.

Larva on the underside of a leaf

Yellowing along the margin of a leaf

MITES

Red Spider Mite - *Tetranychus* spp.

Young and adult mites suck mainly the lower side of leaves by puncturing the epidermal cells with their stylets, resulting in chlorotic patches on the leaves. Leaves may become distorted, yellow and browning leading to premature leaf drop.

Yellowing on the upperside of a leaf

Chlorotic patches on upperside of leaves

Adults and larvae on the underside of a leaf

DISEASES

Damping off - *Pythium, Rhizoctonia*

Pre-emergence damping off or seedling death may occur as a result of a range of soilborne fungal pathogens. The affected seedlings are pale green and exhibit brownish lesions at the base of the stem. The seedlings collapse.

Verticillium wilt

Disease is seed borne. The plants wilt during the warmer parts of the day, recovering at night. Brown discolouration is seen in the cross section of the vascular tissue. The petioles droop in young plants and seedlings can be destroyed. Clearly separated yellow spots are a characteristic symptoms observed on leaves.

Symptoms on leaves

Leaf spot - *Alternaria solani*

Symptoms first appear as small irregular spots on the leaf, fruit and stems, which develop into concentric ringed, necrotic spots. Spots are often surrounded by a yellow halo. On older leaves, lesions may coalesce and kill the leaf. Brown spots may appear on ripening fruit and are subsequently covered by brown mycelium and conidial fructifications. The lesions on the leaves form a brown concave area.

Spot on upperface of a leaf

Late Blight - *Phytophthora capsici* or *P. Parasitica*

Infection is signaled by the appearance of dark-green, water-soaked spots around the stem at soil level, which causes the plant to wilt and die. Spots that are water-soaked and irregularly-shaped also appear on the foliage and fruit. Brown spots appear on ripe or green fruit and develop a concentric ring pattern of brown bands which enlarge until they completely cover the fruit, and later the infected fruit becomes dried.

Symptoms of rot on a fruit

Powdery mildew - *Leveillula taurica, Oidium longipes*

Cholorotic leaf spots form on the upper side of the leaves that become necrotic after a while. The leaves are eventually overgrown by an expanding mycellial mat on the upper surface. *L.taurica* unlike other powdery mildew develops within the host and diffuse yellow spots develop on the upper leaf surface, whilst the powder mass appears on the underside.

Powder mass on the underside of a leaf

Bacterial Wilt - *Ralstonia solanacearum*

The younger leaves are attacked first. The leaves at the end of branches wilt during the heat of the day. Streaky brown discolouration appears on the stem and leaves have a bronze tint. A white, slimy mass of bacteria exudes from vascular bundles when broken or cut, which forms threads.

Complete wilting of a plant

NEMATODES

Root knot nematodes - *Meloidogyne spp.*

The 3rd instar juveniles penetrate the roots and settle in the vascular tissue, causing swellings and malformations on root. Heavy infestations result in stunted growth, wilting, yellowing of leaves. Symptoms similar to water or nutrient deficiency due to the restriction of up take by the roots. Roots attacked by nematodes are prone to secondary infection by other phytopathogenic micro-organisms.

Knotted roots

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

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

Stage	Length of stage	Cutworms		Beetles		Thrips		Whiteflies		Leafminer		Aphid		Bollworm		Jassids		Red Spider mites	
Seed	3 – 5 days																		
Nursery	35 – 40 days																		
From pricking out to flowering	65 – 70 days																		
From flowering to first harvest	85 – 95 days																		
First harvest to peak harvest	60 -70 days																		
From peak to end of harvest	80 – 90 days																		

Stage	Length of stage	Damping off		Bacterial wilt		Verticillium wilt		Early Blight		Late Blight		Powdery mildew		Root Knot Nematodes	
Seed	3 – 5 days														
Nursery	35 – 40 days														
From pricking out to flowering	65 – 70 days														
From flowering to first harvest	85 – 95 days														
First harvest to peak harvest	60 -70 days														
From peak to end of harvest	80 – 90 days														

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. Importance by Country – periods of the year and climate conditions favourable to crop enemies

Key:
TAN = Tanzamnia, KEN = Kenya, ZAM = Zambia, 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.

Cutworms – *Agrotis* spp.

Favourable conditions: Warm dry conditions. Cool soil temperatures encourage feeding activity around the crop root zone.

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

Thrips – *Thrips palmi, Frankiniella occidentalis*

Favourable conditions: Optimal conditions are high temperatures particularly after a bout of rain. Optimal temperature 20°C.

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

Epilachna beetles - *Epilachna dregi*

Favourable conditions: Optimal conditions are warm temperatures, during the rainy season.

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

Flea beetle - *Epitrix cumumeris, Epitrix fasciata* and *E.tuneris*

Favourable conditions: Optimal conditions are warm temperatures, particularly at the beginning of the rainy season.

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

Whiteflies - *Bemisia tabaci, Trialeurodes vaporariorum*

Favourable conditions: Dry warm and sunny conditions encourage adult flight and egg laying activity. Optimal temperature 25°C.

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

Leafminer - *Liriomyza trifolii, L. huidobrensis, L. bryonia*

Favourable conditions: Optimal temperature 30°C. Warm, dry conditions favour development. If pupation takes place in the soil, low soil temperatures will delay emergence.

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

Aphids - *Aphis gossypii*

Favourable conditions: Dry conditions, warm temperatures. Optimal 30°C.

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

Bollworm - *Helicoverpa armigera*

Favourable conditions: Present in certain regions all year round, but optimal conditions are in warm and dry seasons.

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

Jassids - *Amrasca* spp.

Favourable conditions: Optimal conditions are high temperatures after a period of rain. Optimal temperature 20°C.

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

Red Spider Mite - *Tetranychus* spp.

Favourable conditions: Optimal temperatures lie between 26 and 30°C. Mites flourish at relatively low humidity.

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

Damping off - *Pythium, Rhizoctonia, Phytophthora*

Favourable conditions: Temperatures 20 – 26°C favour disease development. High humidity in soil and air favours the spread of the disease, particularly in poorly drained soils.

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

Verticillium wilt

Favourable conditions: Moderately cool temperatures, on av. 20°C.

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

Leaf spot - *Alternaria solani*

Favourable conditions: 28 - 30°C. Heavy dews with frequent rains . Serious in high moisture followed by high temperatures.

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

Late Blight -*Phytophthora infestans*

Favourable conditions: Easily dispersed in wet conditions. Optimal conditions for infection process is 27 – 32°C.

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

Powdery mildew - *Leveillula taurica, Oidium longipes*

Favourable conditions: Moderate temperatures (16 – 27°C), dry and shady conditions. Humidity is required for spore germination, but inhibited by water on the surface of the plant for extended periods.

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

Bacterial Wilt - *Ralstonia solanacearum*

Favourable conditions: Optimal conditions 35 – 37°C (Race 1), 27°C (Race 3). High soil moisture and periods of wet weather are associated with high disease severity.

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

Root knot nematodes - *Meloidogyne* spp.

Favourable conditions: Soil temperatures 26 – 28°C, particularly in light soils. Reproduction can occur all year round in the presence of suitable hosts.

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

2. Main control methods

2.1. Introduction

Eggplant does best on well-drained, fertile, sandy-loam soils at a pH of 6.0-6.5. Poorly drained soils may result in slow plant growth, reduced root systems, and low yields. The best growing temperatures are between 25°- 32°C during the day, and 21°-27°C during the night; plant growth is curtailed at temperatures below 16°C. Additionally, soil temperature below 16°C restricts germination. However, most eggplant is started in the field from transplants.

Eggplant production practices are similar to tomato production (i.e., raised bed mulch system with seepage and/or trickle irrigation). Fields are ploughed and disked to turn under old crop residue, followed by bed shaping, fumigating, fertilizing, and mulching. Fertilizers can be directly injected for those growers using trickle irrigation. Plastic mulch helps retain nutrients by preventing leaching by natural rainfall.

Eggplant can be planted by direct field seeding or as transplants. Stakes must be placed in the rows when plants are 2 to 3 weeks old, and plants are "sandwiched" between two lines of plastic twine that are wrapped around each stake. This procedure can be done by workers three to four times during the growth of the plant.

Upon maturity, eggplant is usually picked once a week, and harvest may last six to eight weeks on any single plant. After the final harvest, plants must be uprooted. Some growers may remove old vegetation by mowing, without the use of herbicides.

Stakes must be sterilized by steam for the next crop. However, stakes can be used again by reinserting the opposite end of the stake in the ground for the second crop without sterilization. Due to the frequency of harvest, preharvest intervals (PHIs) are an important factor when growers select pesticides for use on eggplant.

Eggplants (*Solanum melongena*) are susceptible to a wide range of insect pests that are polyphagous and diseases that also attack other solanaceae crops. In order to restrict their impact, the control strategy should include cultural as well as chemical practices. The use of monitoring techniques including scouting, yellow sticky traps and specific pheromone trapping, will help forecast outbreaks.

Seed treatments are normally applied to protect young plants, and strict phytosanitary practices in the nursery will help reduce early establishment of insect pests and diseases in the field.

Development of hedges between fields will help suppress the migration of insects and dissemination of disease spores into the field, by wind. Eggplants should not be planted consecutively on the same land, nor should it follow other solanaceous crops, such as tomatoes and peppers. In addition, eggplants should not be used as a rotation crop on land that has been treated with herbicides to which eggplant may be sensitive.

2.2. Pest growth cycle or disease cycle and position of control methods and factors influencing development

Based on the stages of development of each pest or disease, the following are the applicable control methods, as well as the effects of natural factors other than those related to climate, which are described in Part 1.4. of this guide. The control methods are then positioned in terms of the plant's development cycle.
N.B.: the illustrations of the cycles represent the different stages of development, but in no case should these illustrations be used to identify pests or diseases. For identification, please return to part 1.2 of this guide.

The control methods for pests or diseases whose cycle is not illustrated are presented in a table.
The second column of the table shows what actions should be taken to control the different stages of development of the pest or the disease shown in the first column.

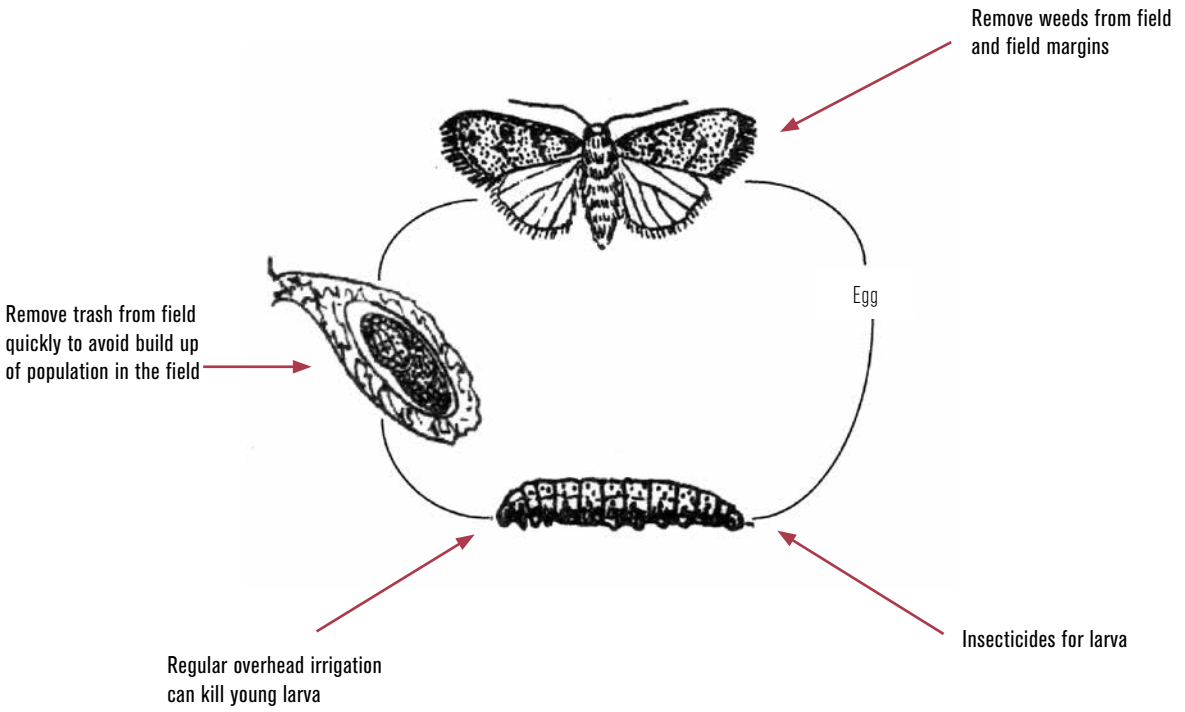
In the second column, actions that can be referred to as "cultivation practices" are shown in green boxes, and actions that can be referred to as "application of plant protection products", in pink boxes.

- Cultivation practices
- Application of plant protection product

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

CUTWORM – *Agrotis* spp.

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



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

During all plant cycle

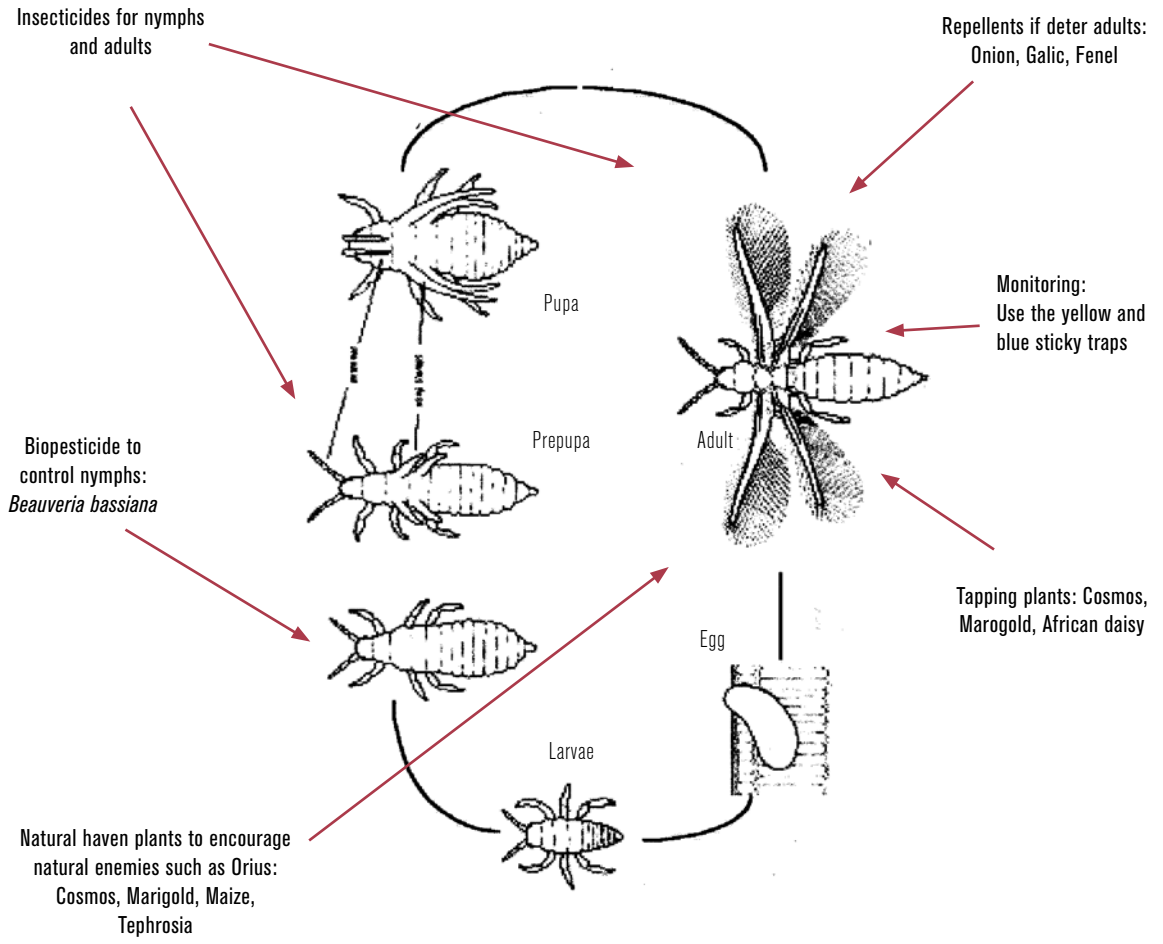
- Remove weeds from field and field margins to suppress the build up of alternate hosts.
- Apply insecticides to target larval stages.
- Regular overhead irrigation can help kill larvae.

After last harvest

- Remove crop trash from field immediately after harvesting, to avoid build up of populations.

THRIPS *Thrips palmi, Frankiniella occidentalis*

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



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

At field preparation

- Plant natural havens at the edges of fields to encourage natural enemies such as *Orius* spp., to establish. Plants such as cosmos, marigold, maize all attract thrips and thereby provide food in addition shelter for *Orius* spp.
- The above crops can also be used as trap crops. These plants can be regularly sprayed or drenched with insecticide to control populations away from the crop.

During all plant cycle

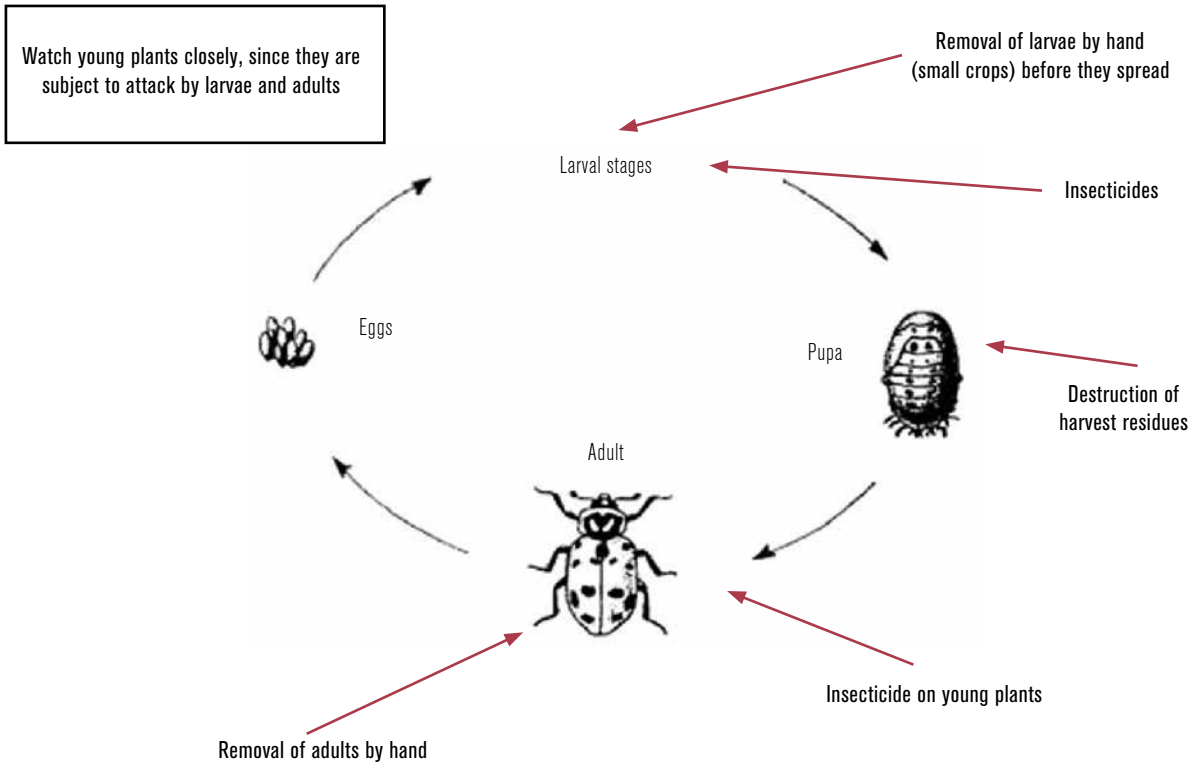
- Garlic and other allium plants can be made into teas and sprayed on a weekly basis on the crop to deter thrips.
- Ensure correct irrigation schedule (avoid over or under watering) and maintain good growing conditions.
- Spray insecticides to kill nymphs and adults.

After last harvesting

- Remove old plants from field quickly to avoid build up of population in the field.

EPILACHNA BEETLES - *Epilachna dregi*

Positioning of control methods in terms of the development cycle 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

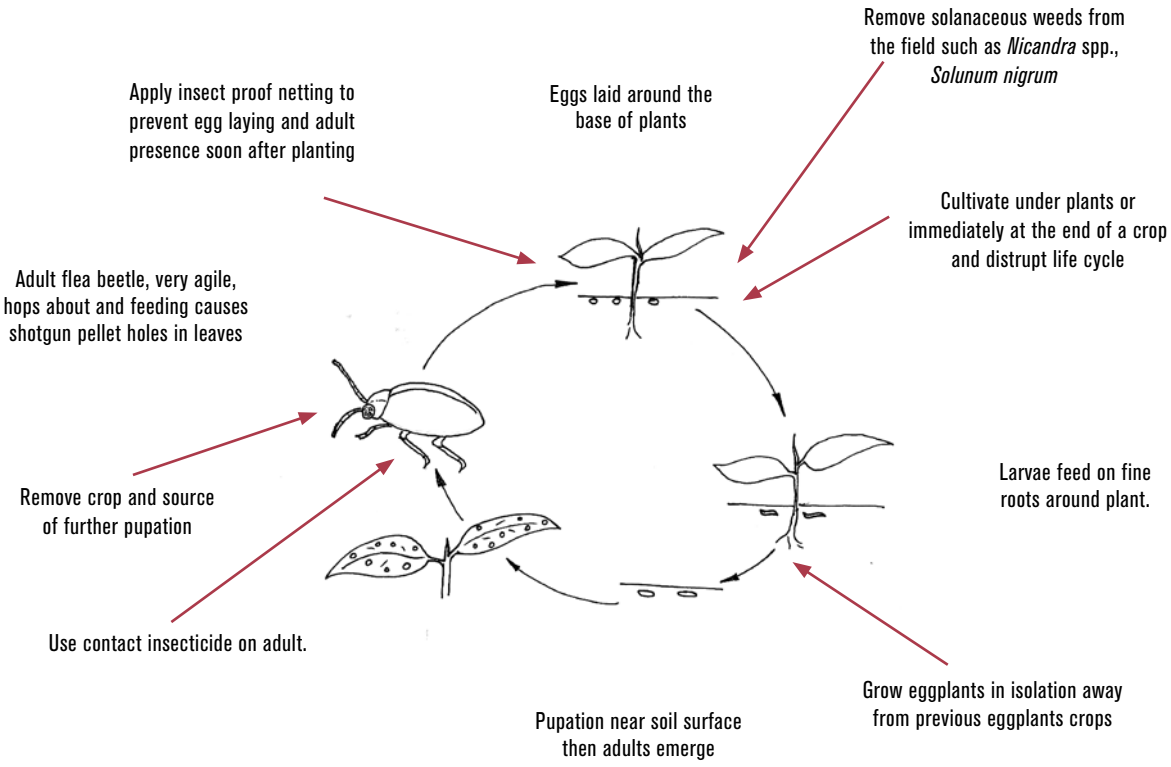
- Removal of larvae and adults by hand (small crops).
- Insecticide on young plants in case of serious outbreak.

After the final harvest

- Destruction of harvest residues.

FLEA BEETLE - *Epitrix cumumeris* and *E.tuneris*

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



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

Field

Before transplanting

- Select production site that is isolate from other eggplants crops to reduce of cross over of flea beetles

After transplanting

- Apply crop covers to control influx of adults and egg laying at the base of plants.

During sensible stage of the plant (see 1.3.)

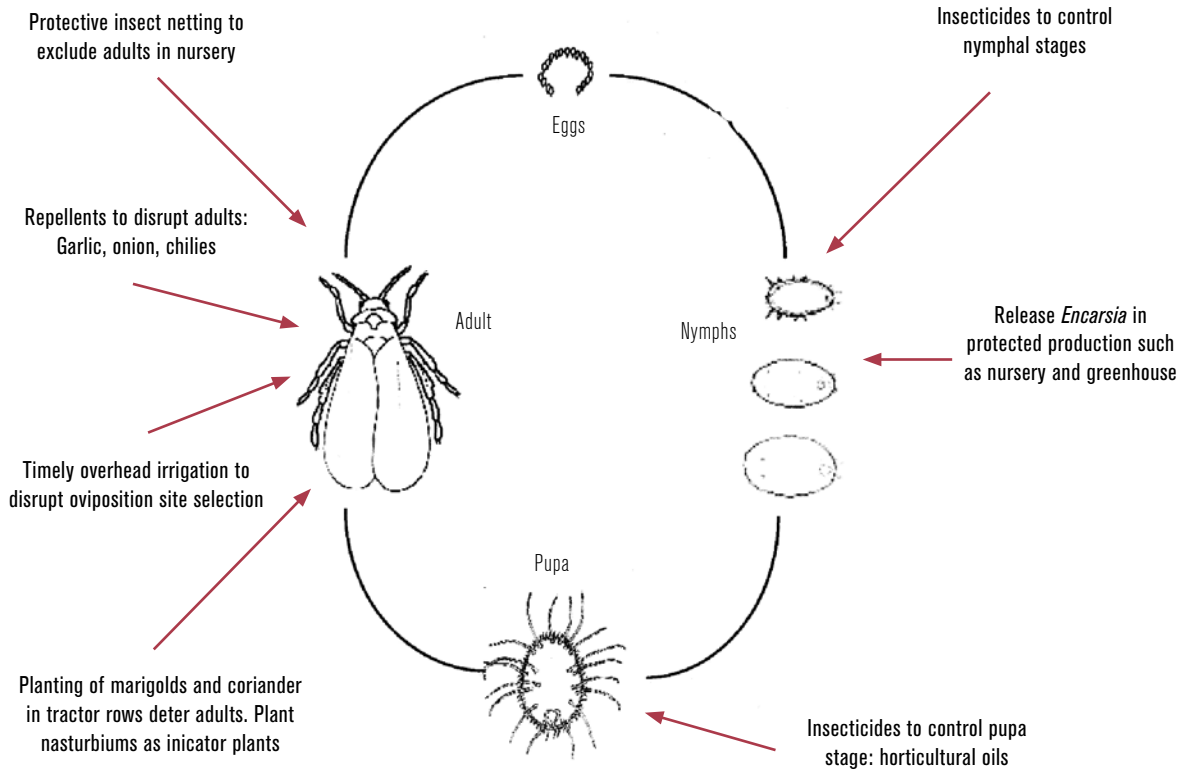
- Cultivate under crops or immediately at the end of a crop to disrupt the life cycle of the flea beetle by destroying eggs and larvae.
- Use repellant sprays such as neem based products.
- Spray contact pesticides for control of Flea beetle adults
- Remove solanaceous weeds from the field such as *Nicandra* spp., *Solunum* nigrum

After last harvesting

- Remove crop and source of further pupation.

WHITEFLY – *Bemisia tabaci, Trialeurodes vaporariorum*

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



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

At field preparation

- Plant *nasturtiums* for use as indicator plants and trap crops when planted around the outside of a nursery.
- Plants such as marigolds and coriander can be planted in tractor rows, to deter whiteflies.

During all plant cycle

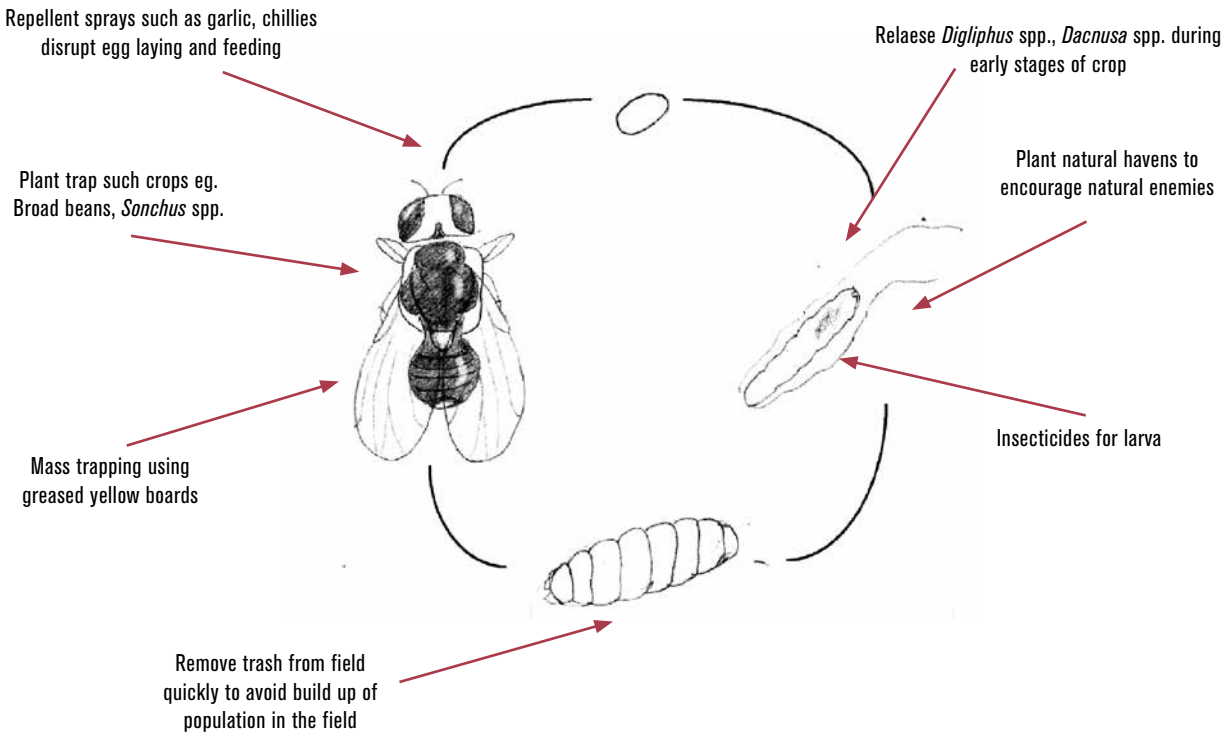
- Garlic sprays either "home-made" or commercial products should be sprayed on a weekly basis to repel adults.
- Cover crop with insect netting to exclude whitefly adults.
- Overhead irrigation can be used to disrupt oviposition site selection.
- *Encarsia formosa* is an effective natural enemy of whitefly nymphs inside a greenhouse or protected nursery area.
- Apply horticultural oil sprays to control nymphs.
- Apply insecticides to target early instar nymphs.

After last harvesting

- Crop trash should be removed and destroyed after harvesting.

LEAFMINER - *Liriomyza* spp.

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



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

At field preparation

- Plant trap crops e.g. broad beans, sonchus weeds to attract adults away from crop.
- Natural havens can be planted on the edge of fields to encourage natural enemies.

During all plant cycle

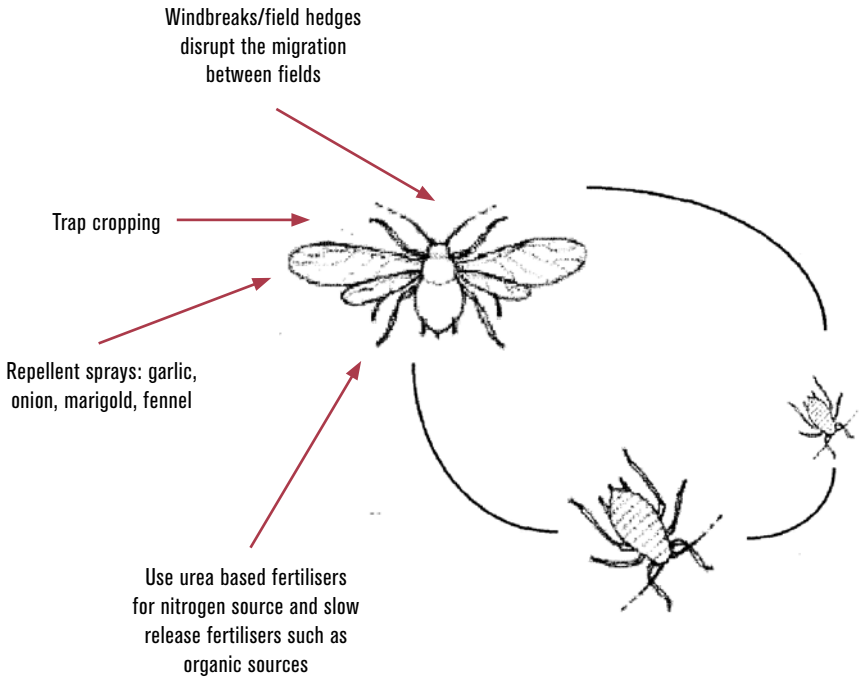
- During peak adult flight activity, big yellow boards coated with white grease can be taken into the field and used to mass trap adults.
- *Diglyphus* spp. and *Dacnusa* spp. are very effective parasitoids of larvae. They can be released in large numbers initially to establish populations, with small regular releases during the crop cycle to maintain levels.
- Spray repellents such as garlic, onion or chilli to repel adults from crop.
- Apply insecticides to target larval stage.

After last harvesting

- Remove trash immediately from field when harvesting has finished to avoid build up of populations.

APHIDS – *Aphis gossypi* and other species

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



To control all stages

- Natural heavens to encourage natural enemies e.g. beetles and hoverflies, *Aphidius*
- Insecticides
- Control ants in the fiweld, as these will disrupt natural enemy activities

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

At field preparation

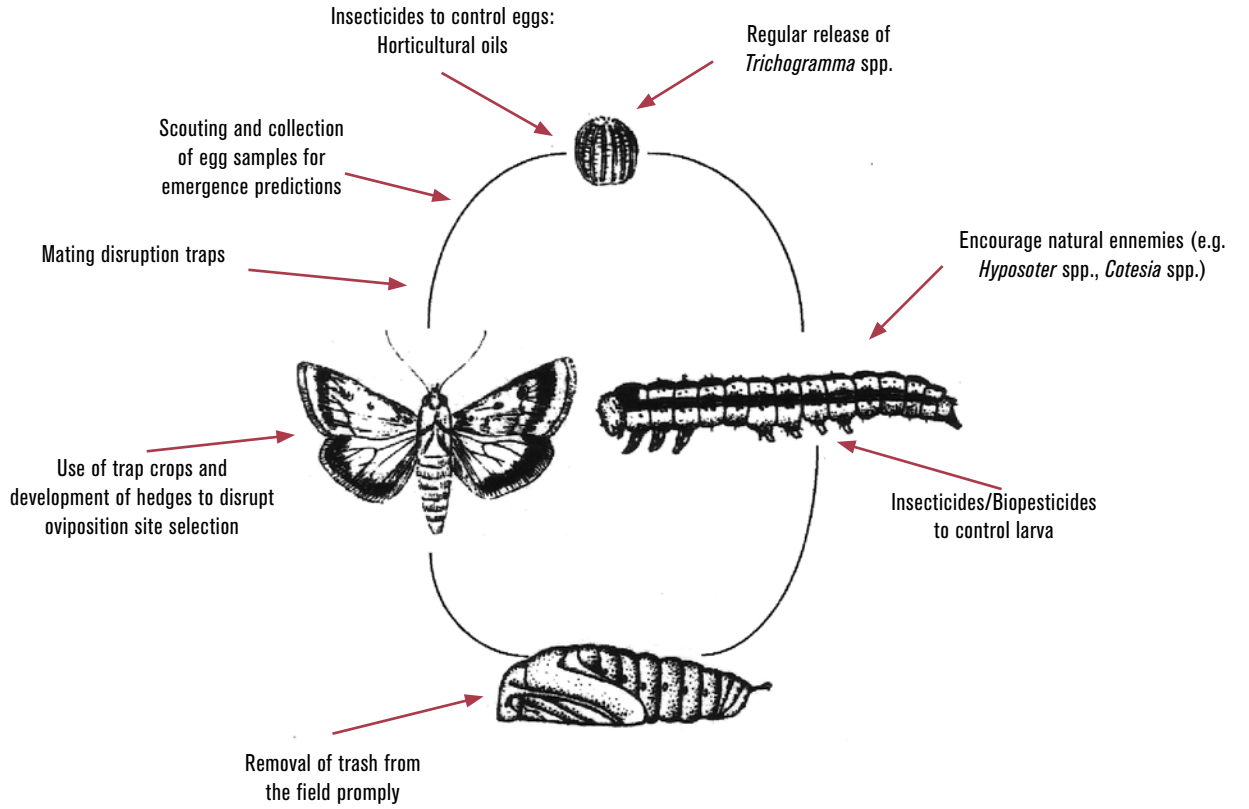
- Natural havens can be planted within or on the hedges of fields to encourage natural enemies, for example coriander, dill, mustard and *Sonchus* weed.
- Plants can be planted to trap aphids away from crop. These trap crops may be sprayed to control the build up of populations.

During all plant cycle

- Remove weeds that are alternate notes for aphids and harbour certain viruses.
- Aphids are attracted to nitrogen levels in plants, use slow release nitrogen based fertilisers to reduce plant attractiveness.
- Repellent sprays such as garlic, onion, chilli and marigolds help to deter aphids from the crop.

BOLLWORM – *Helicoverpa armigera*

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



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

At field preparation

- Plant natural havens at the edge of fields to encourage natural enemies such as *Hyposoter* spp. and *Cotesia* spp.
- Planting of coriander and other scented plants within tractor rows in the field will help to repel adults.

During all plant cycle

- Monitor adult flight activity using pheromone traps to forecast outbreaks.
- Monitoring of eggs is very important for timely control with pesticides. Egg should be collected from the field and placed in perforated plastic bags. The eggs should be monitored daily for signs of hatching. This can aid prediction of egg hatching in the field.
- Mating disruption techniques have been developed for Bollworm (see references).
- The egg parasitoid *Trichogramma* spp. can be released to control bollworm eggs.
- Apply horticultural oil to suffocate eggs.
- Apply insecticides to target larval stages.

After last harvesting

- Remove trash from field immediately after harvesting to avoid build up of pupa in soil.

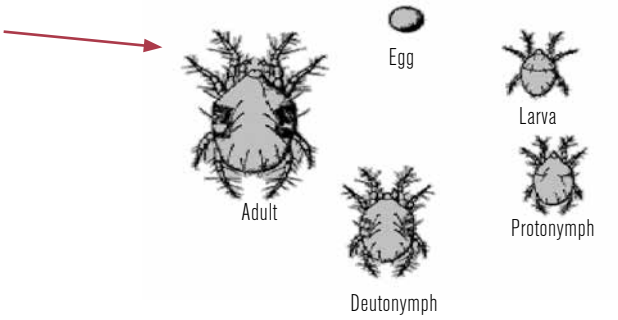
JASSIDS - *Amrasca* spp.

Jassids feeding behaviour is similar to that of aphids or whiteflies and therefore main strategies adopted to control them also have an impact on the former. *(see control sections on aphids and whiteflies)*.

RED SPIDER MITES

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

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



To control all stages

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

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

At field preparation

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

During all plant cycle

- Red spider mites thrive in dry conditions. Applying overhead irrigation on a regular basis will increase the microclimate humidity. This will lead to an unfavourable environment for mite development. The application of overhead also washes off a significant number of mites.
- Dust from farm tracks can get blown onto the webbing created by mites, further protecting them from pesticide control. In addition the photosynthetic capability of the plant is reduced. Any road close to the crop should be dowsed in water on a regular basis to reduce dust.
- Weeding around the field during the crop cycle is not advisable as the mite on these plants will move into the crop.
- Predatory mites, such as *Phytoseuillus persimilis* can be used to suppress populations.
- Products such as starch, milk and oil can be used as sprays to help suppress mite populations.
- Apply acaricides during early development of populations, before webbing formation.

After last harvesting

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

Damping off

Natural factors favourable to the fungus

- Serious in heavy, poorly drained soils, with high pH

Development stage of the fungus	Action	Cultivation stages									
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Germination on aubergine plant	Avoid wounding roots and collar.			X			X				
	Seedbed conditions should not be too moist.	X		X							
	Regulate irrigation programme to avoid overwatering.							X			
	Use of organic material to improve soil structure and pH.			X		X					
	Avoid water logging areas when planting.				X	X	X				
	Apply fungicides as seed treatment to prevent germination.		X								
Development in aubergine plant	Apply fungicides to prevent mycelium development.	X		X			X				
Development on crop or weeds	Remove and destroy *Solanceae* weeds from within and around fields.		X	X		X	X	X	X	X	
	Remove and destroy infected plants.			X			X				
Conservation in the soil	Use clean and/or sterile soil or potting media.	X			X						
	Steam, heat (65°C for 30 minutes) and solar treatment of soil and growing media will help to kill the disease.	X				X					
	Composted bark increases the air filled porosity of media, releases inhibitors as it decomposes, and allows antagonistic soil fungi such as *Trichoderma* sp. to build up.	X				X					
	Media used for seedlings ideally should not be reused, and seedling trays should be sterilised before reuse. Ideally trays should kept off the ground both when stored and in use.	X									

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

Verticillium wilt

Natural factors favourable to the fungus

- At least one day of saturated soil is required before infection occurs. Soil temperature conducive to disease development is 13 – 30°C.

Development stage of the fungus	Action	Cultivation stages									
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Germination on aubergine plant	Do not over irrigate.			X			X	X	X	X	
	Compost may contain antagonists to the pathogen.	X				X					
	Apply fungicides to prevent germination of spores.	X				X					
Development in aubergine plant	Plant crop in black plastic mulch to help reduce severity.			X			X				
	Apply fungicides to prevent mycelium development			X			X	X			
	Maintain a balance of nutrients applied to the plant to promote vigorous growth. Avoid high concentrations of nitrogen.			X			X	X	X	X	
Transport by contamination or water	Where possible avoid irrigating with surface water as it can potentially be contaminated.		X	X			X	X	X	X	
	Take hygiene precautions to avoid contamination.		X	X		X	X	X	X	X	
Development on crop or weeds	Remove *solanacae* weeds from within and around field.				X	X	X	X	X		
Conservation in the soil	Carry out a good crop rotation which avoids repeated plantings of *solanacae* crops on the same piece of land, follow with crops such as cereals. Keep rotation crop free of weeds as disease has many different weed hosts.				X						
	Remove and destroy dead plants and crop trash, ensuring all the root system if also removed.							X	X	X	X
	Steam soil used for planting media (82°C for 30 mins) or solar sterilise.	X							X		

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

Early Blight – *Alternaria solani*

Natural factors favourable to the fungus

- Most severe when plants are stressed (low nitrogen fertility, nematode attack or heavy fruit load)

Development stage of the fungus	Action	Cultivation stages									
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Germination on aubergine plant	If overhead irrigation used, apply early in day to allow leaves to dry quickly. Ideally use drip irrigation.			X			X	X	X	X	
	Apply fungicides to prevent germination of spores.			X			X	X	X	X	
Development in aubergine plant	Plant crop in raised, well drained beds.					X					
	Provide optimum growing conditions and fertility.			X		X	X	X	X	X	
	Apply fungicides to prevent development			X			X	X	X	X	
	Apply salt preparation (2.5% Vinegar+ 0.5% Salt+0.25% teepol) to suppress development.			X			X	X	X	X	
Conidia production on host plants	Where possible remove infected leaves.							X	X	X	
Transport by wind or water	Plant windbreaks and in-field barriers to help suppress the dispersal of spores.				X	X					
	Mulch crop to prevent splashing spores onto lower leaves.						X				
Development on crop or weeds	Remove *solanacae* weeds from within and around field.		X	X			X	X	X	X	
Conservation in the soil	Carry out a good crop rotation which avoids repeated plantings of *solanacae* crops on the same piece of land.				X						
	Crop trash should be removed from the field and destroyed immediately after harvest.										X

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

Late Blight – *Phytophthora capsici* or *P. parasitica*

Natural factors favourable to the fungus

- Excessive water and poorly drained fields leads to optimal conditions for infections. Infection likely to take place when temperature does not fall below 10°C and relative humidity not below 75% for a period of 48 hours (Beaumont or Smiths Period).

Development stage of the fungus	Action	Cultivation stages									
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Germination on aubergine plant	Care should be taken to avoid wounding seedlings during transplanting.						X				
	Prune should be carried out in the morning to allow the wound to dry.							X			
	Irrigate in the morning so that leaves do not remain wet for too long.			X			X	X	X	X	
	Apply fungicides to prevent germination of spores.			X			X	X	X	X	
Development in aubergine plant	Avoid excessive application fertiliser to prevent mycelium development. Use a slow-release fertiliser.						X	X	X		
	Apply fungicides to prevent mycelium development.			X			X	X	X	X	
	Avoid excessive nitrogen fertilisation that makes the resulting foliage more susceptible.			X			X	X	X	X	
Transport by wind or water	Plant tall growing non-host crops between blocks, or plant hedges, to reduce the movement of spores between fields.				X	X					
	Use mulch to reduce movement of spores by rain splash.										
Development on crop or weeds	Remove *solanacae* weeds from within and around field.				X	X	X	X	X	X	
Conservation in the soil	Carry out a good crop rotation which avoids repeated plantings of *solanacae* crops on the same piece of land.				X						
	Crop trash should be removed from the field and destroyed immediately after harvest.										X

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

Powdery Mildew - *Leveillula taurica*												
Development stage of the fungus	Action	Cultivation stages										
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Germination on aubergine plant	Mulch crop at transplanting to promote a microclimate non conducive to the germination of spores on older leavcs.						X				
	Plant in sunny areas.				X						
	Overhead irrigation will wash spores off plant.			X			X	X	X	X	
	Apply fungicides to prevent germination of spores.			X			X	X	X	X	
	Apply a medium oil as spray (do not apply within 2 weeks of a sulphur spray).							X	X	X	
Development in aubergine plant	Avoid excessive application fertiliser to prevent mycelium development. Use a slow-release fertiliser.		X	X		X	X	X	X		
	Apply fungicides to prevent mycelium development.			X			X	X	X	X	
	Prune to allow good aeration.							X			
Conidia production on host plants	Apply biocarbonate of soda as spray to suppress conidia development on mycelial growth.			X			X	X	X	X	
Transport by wind or water	Plant tall growing non-host crops between blocks, or plant hedges, to reduce the movement of spores between fields.				X						
	Use mulch to reduce movement of spores by rain splash.						X				
Development on crop or weeds	Remove *solanacae* weeds from within and around field.		X	X	X	X	X	X	X		
Conservation in the soil	Carry out a good crop rotation which avoids repeated plantings of solanacae crops on the same piece of land.				X						
	Crop trash should be removed from the field and destroyed immediately after harvest.										X

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

Bacterial Wilt –*Ralstonia solanacearum*

Natural factors favourable to the fungus

- Prevalent in sandy, loam and clay soils. Optimal development at temperatures 35 – 37°C.

Development stage of the bacteria	Action	Cultivation stages									
		Nursery substrate and environment preparation	Sowing	Nursery	Choice of piece of land	Field preparation	Transplanting	From transplanting to first harvest	From first harvesting to peak of harvesting	From peak of harvesting to end	After last harvesting
Infection on aubergine plant	Avoid damage to roots during transplanting and weeding.						X	X	X		
	Do not use uncertified seed.		X								
Development in aubergine plant	Mulch crop to help suppress disease.						X				
Transport by equipment or water	Avoid contaminated water. If solanacae plants are grown up river and irrigation water is taken from the river, samples should be tested regularly. If contaminated treat with peroxygen or chlorine dioxide.			X			X	X	X	X	
	Regularly clean and disinfect all machinery and equipment.					X					
	Avoid waterlogging from irrigation			X	X	X	X	X	X	X	
	Intercrop with maize, beans and other non-host plants will reduce spread of inoculum.					X					
Development on crop or weeds	Remove *solanacae* weeds from within and around field to reduce secondary infection from alternative hosts.					X	X	X	X	X	
Conservation in the soil	Carry out a good crop rotation which avoids repeated plantings of *solanacae* crops on the same piece of land.				X						
	Crop trash should be removed from the field and destroyed immediately after harvest.										X

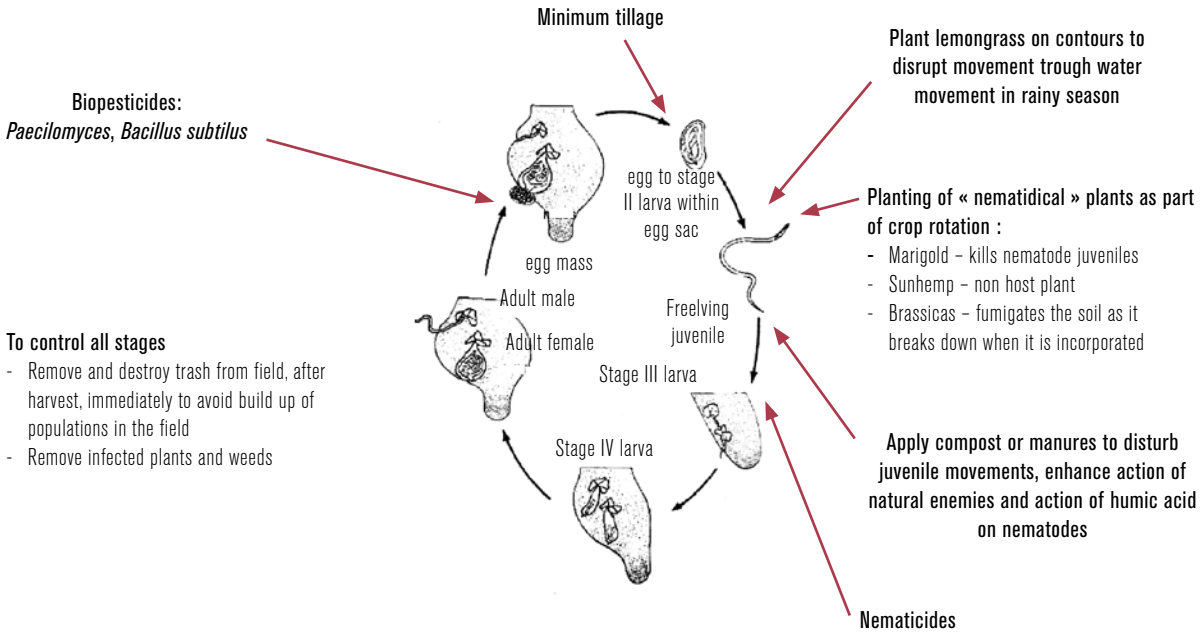
X = action to be taken at the cultivation stage shown in the corresponding column

NEMATODES – *Meloidogyne* spp.

Natural factors favourable to the fungus

- Moist soil conditions stimulate egg hatching, present all year round under irrigated crops.
- Inhabit all types of soil, but prefer those with high sand content.

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



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

At field planting

- Soil samples can be taken regularly before planting and during crop development to monitor the level of nematode build up.
- Planting marigolds (*Tagetes*) and sunhemp (*Crotalaria*) following a crop that has supported a build up of nematodes will help reduce the population before the next crop. At flowering stage the plants should be turned into the soil, unless seed is collected, to avoid the species becoming a weed problem in the subsequent crop.
- Leafy brassicas can be used as part of a rotation, when the brassicas are turned into the soil, they break down releasing glucosinolates and isothiocynates, which fumigate the soil.
- Lemon grass and Vetiver grass can be used as a barrier for nematode migration when planted on the contours of a slope between fields.

During all plant cycle

- Samples of plants that are suspected of having nematodes should be carefully dug out, making sure soil remains around the roots. The roots should then be carefully inspected for signs of nematode nodules.
- Both *Paecilomyces* and *Bacillus subtilus* can be incorporated into the soil to control nematode eggs. However, as they do not control the mobile juvenilles they need to be used as part of the long term nematode control maintenance programme.

After Harvesting

- Remove trash from the field, ensuring roots are also removed, immediately after harvesting, to avoid population build up in the soil.

2.3. Cultivar resistance or tolerance

The following table provides information on example of varieties of eggplant that are selected for specific tolerance or resistance to diseases and nematodes.

Company	Cultivar	TMV virus	ToMV virus	Verticillum wilt	Rootknot Nematodes
	Indian eggplants	X			
	Thai eggplants				X
Hygrotech	Bambino (Baby eggplant),	X			
Hygrotech	Black beauty, Epic, Night Shadow, Cloud nine		X		
USA	Blacknite, Classy Chassis, , Epic, Vernal	X			
	Black pride, Classic, Epic, Vernal			X	

TMV = Tobacco mosaic virus.
ToMV =Tomato Mosaic Virus.

3. Crop monitoring and intervention thresholds

There are many different ways of scouting eggplants. Generally 50 plants can be selected at random per field. Ten sampling sites are selected along a "W" pattern, at each site 5 plants are inspected.

Alternatively, 20 sampling sites can be selected in a "W" pattern, or if the plants are grown on raised beds , a parallel pattern can be used . At each site 10 plants are inspected. These sampling sites can be either pegged or un-pegged.

At each sampling site the number of plants affected by a particular problems is recorded. The data for all the sampling sites is collated and a % plants affected is calculated.

Problem	Stage of crop	Threshold level % of plant affected
Aphids	Nursery Vegetative Fruiting	1% 30% 10%
Thrips	Vegetative Flowering	20% 10%
Whiteflies	Nursery Vegetative Fruiting	1% 30% 10%
Leafminer	Nursery All other stages	1% 40%
Bollworm	All stages	10%
Red spider mite	Nursery Vegetative	1% 25%

Yellow sticky traps can be used to monitor aphids, leafminer, thrips and whiteflies.

Pheromone traps can be used to monitor bollworm moth activity. The traps should be placed in a grid pattern through the cropping areas. Lures should be replaced every 6 – 8 weeks in warmer weather, but catch rate patterns should be observed to determine lure replacement frequency for specific locations. Trap data should be correlated with rainfall and temperature.

Diseases

Preventative sprays should be applied at certain times of the year. Decisions should be based on historical data relating to times of year when optimal conditions are expected.

Treatments of diseases should be implemented at first sign of symptoms and repeated every 7 days when optimal conditions for the disease prevail.

4. Plant Protection Products 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 or biocontrol agent 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 minima 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

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

Some GAP (highlighted with yellow boxes in the tables thereafter) was tested by PIP on aubergine in 2010/11 under tropical conditions in Dominican Republic.

The list of active substances proposed has been drawn up taking into account the products used by ACP producers and the products registered in ACP countries. It is nevertheless worth noting that 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.

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 and maltodextrin can trap aphids, whiteflies, spider mites and leafhopers as well as external fungus like powdery mildews when applied correctly. Calcined kaolin can repel various insects. Extract of Citrus can control various insects and mites by dessicating their skin. These substances have no possible resistance and no residues of concern but one should check locally authorization for use on crops.

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

Cutworms - *Agrotis* spp.

Strategy: Apply treatment as drench before transplanting seedlings and/or after transplanting.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 3 – Pyrethroids (sodium channel modulators)													
Alpha cypermethrin	12	2	7	Usually sprayed before flowering			■		■	■			
Lambda cyhalothrin	12.5	3	7	Usually sprayed before flowering			■		■	■			
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	/	/	Usually sprayed before flowering			■		■	■			
Group 1 – organophosphates and carbamates													
Chlorpyrifos-ethyl	/	/	/	Usually sprayed before flowering			■		■	■			
Dimethoate	400	2	14	Usually sprayed before flowering			■		■	■			
Not classified													
Oxymatrine	/	/	/	Usually sprayed before flowering			■		■	■			

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ elements of the recommended GAP not available

Thrips

Strategy: Generally treat according to threshold levels based on scouting. Apply systemic chemicals during early flowering stage to reduce blemishes on developing fruit.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	/	/	2						■	■	■	■
Group 3 – Pyrethroids (sodium channel modulators)													
Alpha-cypermethrin	12	2	/	3	7	14			■	■			
Beta-cyfluthrin***	10	3	7	3	3	7			■	■	■		
Bifenthrin	24	2	/	5	5	14			■	■			
Deltamethrin	12.5	3	7	3	/	/			■	■			
Pyrethrins	100	/	/	2	2	2			■	■	■	■	■
Group 4 – Nicotinic acetylcholine receptor agonists/antagonists													
Imidacloprid	150	1	n.a.	7	/	/			■	■			
Thiacloprid ***	80	3	7	10	7	14			■	■			
Group 5 – Spynosines													
Spinosad	96	3	7	3	10	10				■	■		
Not classified													
Fatty Acid	/	/	/	2	2	2				■	■	■	■
Oxymatrine	/	/	/	2	2	2				■	■	■	■
Group 6 - Avermectins													
Abamectin	18	2	7	3	3	3				■	■	■	■
Group 1 – organophosphates and carbamates													
Diméthoate	400	2	14	14	14	14			■	■			
Malathion	/	4	7	21	21	21			■	■			

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
*** Ready mixt fomulation (beta-cyfluthrin + thiacloprid)
/ Elements of the recommended GAP not available
n.a. non applicable

Beetles

Strategy: Treat seed to protect early stages of growth. Treat larva stage in the soil by drenching as a preventative treatment. Apply treatment to target adults when threshold are met.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 4 – Nicotinic acetylcholine receptor agonists/antagonists													
Imidacloprid	/	1	n.a.	Traitement semences				■					
Thiacloprid***	80	3	7	10	7	14			■	■			
Group 3 – Pyrethroids (sodium channel modulators)													
Apha-cypermethrin	12	2	/	3	7	14			■	■			
Bifenthrin	20-40	2	/	5	5	14			■	■			
Beta-cyfluthrin***	10	3	7	3	3	7			■	■	■		
Deltamethrin	12.5	3	7	3	/	/			■	■			
Lambda-cyhalothrin	12.5	2	7	3	3	/			■	■			
Cypermethrin	/	2	/	3	7	14			■	■			
Group 1 – organophosphates and carbamates													
Dimethoate	400	2	14	14	14	14			■	■			

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
*** Ready mixt fomulation (beta-cyfluthrin + thiacloprid)
n.a. : not applicable

Whiteflies

Strategy: Spray according to threshold levels set and then treat at weekly intervals during optimal conditions.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 3 – Pyrethroids (sodium channel modulators)													
Beta-cyfluthrin***	10	3	7	3	3	7				■	■		
Bifenthrin	40	2	/	5	5	14			■	■			
Deltamethrin	12.5	3	7	3	/	/				■			
Pyrethrin	100	/	/	2	2	2			■	■	■	■	
Group 4 – Nicotinic acetylcholine receptor agonists/antagonists													
Acetamiprid	25	2	7	7	7	/			■	■			
Imidadoprid	/	1	n.a.	Seed treatment				■					
Thiacloprid***	80	3	7	10	7	14			■	■			
Thiamethoxam	/	1	n.a.	Seed treatment				■					
Thiamethoxam	100	2	7	7	1	14			■	■			
Group 1 – Organophosphates and carbamates													
Dimethoate	400	2	7	14	14	14			■	■			
Malathion	/	4	7	21	21	21			■	■			
Methomyl	450	2	/	7	/	/			■	■			
Group 23 – Inhibitors of acetyl CoA carboxylase													
Spirotetramate	75-150	3	7	3	3	/			■	■			

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
*** Ready mixt fomulation (beta-cyfluthrin + thiacloprid)
n.a. : not applicable

Leafminer – *Liriomyza trifolii*

Strategy: Natural enemies, primarily parasitic wasps (*Diglyphus* spp.), control leafminer. *Diglyphus isaea* is commercially available in Kenya for use on vegetables. Sprays, therefore, should be applied according to threshold levels set to minimise disruption of natural controls. In seedlings most mines occur on cotyledons and first true leaves. If populations build to high levels when seedlings only have four or five leaves, treatment is necessary. Avoidance of broad spectrum chemicals to control other pests will often prevent leafminer outbreaks.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	/	/	2	2	2							
Group 6 - Avermectins													
Abamectin	18	2	7	3	3	3							

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available

Aphids

Strategy: The presence of winged adults indicate the development of new colonies, monitor flight activity using yellow sticky traps. Apply treatment according to threshold levels based on scouting and sticky trap counts. Systemic chemicals may be applied to protect young plants when the crop is grown during optimal conditions for colony development. Where possible, use selective chemicals to avoid disruption of natural enemies. It is possible to control aphids using Aphidius transcaspinus a parasitic wasp which is registered for use on vegetables in Kenya.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	/	/	2					■	■	■	■	■
Group 3 – Pyrethroids (sodium channel modulators)													
Betacyfluthrin***	10	3	7	3	3	7				■	■		
Bifenthrin	40	2	/	5	5	14			■	■			
Deltamethrin	12.5	3	7	3	/	/			■	■			
Pyrethrin	100	/	/	2	2	2			■	■	■	■	■
Group 4 – Nicotinic acetylcholine receptor agonists/antagonists													
Acetamiprid	25	2	7	7	7	/			■	■			
Imidacloprid	150	1	n.a.	7	/	/			■	■			
Thiacloprid***	80	3	7	10	7	14			■	■			
Thiamethoxam	100	2	7	7	1	14			■	■			
Not classified													
Petroleum oil	/	/	/	2	2	2			■	■	■	■	■
Oxymatrine	/	/	/	2	2	2			■	■	■	■	■
Group 1 – Organophosphates and carbamates													
Chlorpyrifos-methyl	680	1	n.a.	3	3	7			■	■	■		
Dimethoate	400	2	7	14	14	14			■	■			
Malathion	/	4	7	21	21	21			■	■			
Methomyl	450	2	/	7	/	/			■	■			
Pirimicarb	125	/	/	7	7	/			■	■			
Group 23 – Inhibitors of acetyl CoA carboxylase													
Spirotetramate	75-150	3	7	3	3	/							

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
*** Ready mixt fomulation (beta-cyfluthrin + thiacloprid)
n.a. : not applicable

Bollworm – *Helicoverpa armigera*

Strategy: Apply treatments when larvae are at 1st and 2nd instar stage. Suppress population build up during early stages of plant growth (before flowering) to reduce infestation during fruit development. When larvae move into fruit, they are protected from chemical treatment. Therefore, it is crucial to target new hatchlings before they enter the fruit.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 11 – Microbial disruptors of insect midgut membranes													
Bacillus thuringiensis	800,000 ui	3	5	2	2	2					■	■	■
Group 3 – Pyrethroids (sodium channel modulators)													
Bifenthrin	20	2	/	5	5	14					■		
Deltamethrin	12,5	3	7	3	/	/					■		
Lambda cyhalothrin	12,5	2	7	3	3	/					■		
Pyrethrin	100	/	/	2	2	2					■	■	■
Group 22 – Voltage-dependent sodium channel blockers													
Indoxacarb	37,5	3	7	3	3	/					■		
Group 5 – Spynosines													
Spinosad	96	3	7	3	10	10					■	■	
Group 6 : Avermectins													
Emamectin benzoate	20	3	7	3	3	3					■	■	■
Group 15 : Inhibitors of chitin biosynthesis, type 0													
Diflubenzuron	/	/	/	/	/	/					■		
Group 28 : Ryanodine receptor modulators													
Chlorantraniliprole	50-75	2	7	3	3	/					■		
Flubendiamide	48-72	/	/	3	/	/					■		

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
iu = International units

Red Spider Mite

Strategy: Commerce treatment at early stages of population development if weather conditions are optimal for mites (21°C, low humidity), before webbing starts to form (as this inhibits penetration of chemicals). Treatment should be applied particularly during vegetative growth of plant, to reduce build up of population during harvesting, when acaricides with suitable PHI are limited. Spider mites become rapidly resistant to insecticides. A strict pesticide resistance management strategy should be adopted. Amblyseius californicus and Phytoseiulus persimilis are commercially available in Kenya for use on vegetables to control spider mites.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 6 - Avermectins													
Abamectin	18	2	7	3	3	3							
Group 3 – Pyrethroids (sodium channel modulators)													
Bifenthrin	40	2	/	5	5	14							
Group 12													
Tetradifon	/	/	/	15	15	15							
Not classified													
Sulfur	6, 000	/	/	2	2	2							
Oxymatrine	/	/	/	2	2	2							

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
n.a. : not applicable

Damping off – *Pyhtium, Rhizoctonia, Fusarium Phytophthora* sp.

Strategy: Treatments can be applied to the seed and soil. Seed treatments are the most effective, particularly when combined with substrate treatment at planting in the nursery. Treatments may also be applied at transplanting, if there is a risk in chosen field, where optimal conditions apply (poorly drained, acidic soil, high humidity with soil temperatures between 28 to 30°C).

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group M: Multisite activity													
Copper oxychloride	960-1,280	/	/	3	/	/			■	■			
Thiram	/	Seed treatment	n.a.	/	/	/		■					
Group 3: DMI - fungicides + Group 20 : Phenylureas													
Imazalil + pencycuron	/	Seed treatment	n.a.	/	/	/		■					
Group 2 : dicarboximides													
Iprodione	1 000	4	/	3	/	/			■	■			
Group 28 : carbamates													
Propamocarb hydrochloride	14ml/ m^2 with a product at 53 %	2	15	/	/	/			■	■			
Propamocarb Hcl + fosetyl-Al	Preventive: 0.08 ml/ plant with a product at 53 %; curative: 0,15 ml/ plant	2	15	/	/	/			■	■			
Biofungicides													
Trichoderma harzianum *Trichoderma gamsii*	/	/	/	2	2	2		■					

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
n.a. : not applicable

Early Blight – *Alternaria solani*

Strategy: When optimal conditions prevail, spray at first sign of symptoms and then every 7 – 10 days depending on fungicide.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 11 : QoI fungicides													
Azoxystrobin	250	3	7	3	3	10							
Pyraclostrobine***	97.6	3	7	3	3	7							
Group M: Multisite activity													
Copper oxychloride	1,500	/	/	3	/	/							
Chlorothalonil	1,500	3	7	3	14	14							
Mancozeb	1,600	4	7	3	21	21							
Propineb	1,400	/	/	/	/	/							
Group 3: DMI - fungicides													
Difenoconazole	/	/	/	/	/	/							
Tebuconazole	125	/	/	/	/	/							
Group 7 : SDHI fungicides													
Boscalid***	206.4	3	7	3	3	10							
Group1 : MBC fungicides													
Carbendazim	200	2	7	3	10	10							
Group 2 : dicarboximides													
Iprodione	1,000	4	/	3	/	/							

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
*** Ready mixt fomulation (boscalid + pyraclostrobine)

Late Blight – *Phythopthora* spp.

Strategy: Use preventative sprays when optimal conditions are expected, apply treatment every 7 – 10 days.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 11 : QoI fungicides													
Azoxystrobin	250	3	7	3	3	10			■	■	■		
Chlorothalonil	1,500	3	7	3	14	14			■	■			
Group M: Multisite activity													
Copper	1,500	/	/	3	/	/			■	■			
Mancozeb	1,600	4	7	3	21	21			■	■			
Group 4 : PhenylAmides													
Metalaxyl-M	/	/	/	/	/	/			■				
Unknown mode of action													
Cymoxanil	/	/	/	/	/	/			■				

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available

Powdery mildew

Strategy: Apply spray at first sign of disease, particularly when conditions are conducive to spread of infection (dry, warm conditions during the day, with high night humidity, but not free water).

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 11 : QoI fungicides													
Azoxystrobin	250	3	7	3	3	10			■	■			
Pyraclostrobin***	97.6	3	7	3	3	7			■	■	■		
Trifloxystrobin	250	2	7	3	14	14			■	■			
Group M: Multisite activity													
Sulfur	4,500	4	10	2					■	■	■	■	
Group 3: DMI - fungicides													
Difenoconazole	/	/	/	/	/	/			■				
Myclobutanil	75	4	10	3	/	/			■	■			
Propiconazole	/	/	/	/	/	/			■				
Tebuconazole	/	/	/	/	/	/			■				
Triadimefon	/	/	/	/	/	/			■				
Group 7 : SDHI - fungicides													
Boscalid***	206,4	3	7	3	3	10			■	■	■		
Group 1 : MBC fungicides													
Carbendazim	200	2	7	3	10	10			■	■	■		
Thiophanate-methyl	/	/	/	/	/	/			■				

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
*** Ready mixt fomulation (boscalid + pyraclostrobine)

Root knot nematodes – *Meloidogyne* spp.

Strategy: Apply treatments as part of a long term control programme. Apply treatment before or at transplanting of seedlings as soil treatment to prevent juveniles entering roots.

Active substance	Recommended GAP*						Proposed application period						
				PHI in days									
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ**	Soil preparation	Sowing	Nursery	Planting to flowering	Flowering to first harvest	First harvest to peak of harvest	Peak of harvest to end harvest
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	1	n.a.	application avant plantation									
Group 1 – Organophosphates and carbamates													
Cadusafos	/	1	n.a.	Application before planting									
Carbofuran	1,635	1	n.a.	Application before planting No residues found									
Carbosulfan	300	1	n.a.	Application before planting No residues found									
Ethoprophos	/	1	n.a.	Application before planting									
Oxamyl	480	1	n.a.	Application before planting No residues found									

* The elements of the recommended GAP shown here allow to comply with the EU MRL, the Codex MRL or the LOQ. (see part 6 of this guide).
** PHI based on the EU LOQ value
/ Elements of the recommended GAP not available
n.a. : not applicable

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

Active subsance	Commercial product tested	Concentration	Manufacturer	Trials	
				Year	Country
Abamectin	Vertimec 1.8 EC	18 g/l	Syngenta	2010/2011	Dominican Republic
Azoxystrobine	Amistar 50 WG	500 g/kg	Syngentra	2010/2011	Dominican Republic
Boscalid + pyraclostrobine	Bellis WG	152 + 128 g/kg	BASF	2010/2011	Dominican Republic
Carbendazim	Derosal 50 SC	500 g/l	Bayer CropScience	2010/2011	Dominican Republic
Carbofuran	Furadan	30 g/kg	FMC	2010/2011	Dominican Republic
Carbosulfan	Marshal 20 EC	200 g/l	FMC	2010/2011	Dominican Republic
Chlorothalonil	Bravo 72 SC	720 g/l	Syngenta	2010/2011	Dominican Republic
Dimethoate	Trizol 40 EC	400 g/l	/	2010/2011	Dominican Republic
Emamectine benzoate	Proclaim 5 SG	50 g/kg	Syngenta	2010/2011	Dominican Republic
Mancozeb	Dithane 80 NT	800 g/kg	Dow AgroSciences	2010/2011	Dominican Republic
Oxamyl	Vydate Azul 24 SL	240 g/l	Dupont	2010/2011	Dominican Republic
Spinosad	Spinoace 12 SC	120 g/l	Dow AgroScience	2010/2011	Dominican Republic
Thiacloprid + Beta-cyfluthrin	Monarca 112,5 SE	100 + 12.5 g/l	Bayer CropScience	2010/2011	Dominican Republic

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

5. Existing registrations

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

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

Insecticides and acaricides

Active substance	Kenya	CSP	Côte d'Ivoire	Ghana
Abamectin	Vegetable	Vegetable	Vegetable	Vegetable
Acetamiprid	/	Vegetable	Vegetable	Vegetable
Alpha-cypermethrin	All crops	/	/	Vegetable
Azadirachtin	Horticultural crops	/	/	/
Bacillus thuringiensis var. *kurstaki*	Vegetable	/	Vegetable	Vegetable
Beta-cyfluthrin	/	/	/	Vegetable
Bifenthrin	Vegetable	/	Vegetable	/
Chlorantraniliprole	/	All crops	/	/
Chlorpyrifos-ethyl	/	Vegetable	Vegetable	Vegetable
Chlorpyrifos-methyl	/	Vegetable	/	/
Cypermethrin	Vegetable	Vegetable	Vegetable	Vegetable
Deltamethrin	Vegetable	/	Vegetable	Vegetable
Diflubenzuron	Vegetable	/	/	/
Dimethoate	/	Vegetable	/	Vegetable
Emamectin benzoate	/	/	/	/
Flubendiamide	/	/	Eggplant	/
Imidacloprid	/	/	Vegetable	Vegetable
Indoxacarbe	/	/	Vegetable	/
Lambda-cyhalothrin	Vegetable	Vegetable	Vegetable	Vegetable
Malathion	Vegetable	/	Vegetable	/
Maltodextrin	/	/	/	Vegetable
Methomyl	Vegetable	Vegetable	/	/
Oxymatrine	/	/	/	Vegetable
Pirimicarb	Vegetable	/	/	/
Pyrethrin	Vegetable	/	/	/
Spinosad	Vegetable	/	/	/
Spirotetramate	/	/	Vegetable	Vegetable
Tetradifon	Vegetable	/	/	/
Thiacloprid	Eggplant and vegetable	/	/	/
Thiamethoxam	Vegetable	/	Vegetable	Vegetable

Fungicides

Active substance	Kenya	CSP	Côte d'Ivoire	Ghana
Azoxystrobine	/	Vegetable	Vegetable	Vegetable
Carbendazim	/	/	Vegetable	Vegetable
Chlorothalonil	/	/	Vegetable	/
Copper	Vegetable	/	Vegetable	Vegetable
Cymoxanil	Vegetable	/	/	/
Difenoconazole	/	/	/	Vegetable
Foestyl-Al	/	/	/	Vegetable
Iprodione	Vegetable	/	Vegetable	/
Mancozeb	Vegetable	Vegetable	Vegetable	Vegetable
Metalaxyl-M	Vegetable	All crops (on seeds)	Vegetable	Vegetable
Myclobutanil	/	Vegetable	/	/
Propiconazole	/	/	/	Vegetable
Propineb	Vegetable	/	/	Vegetable
Sulfur	Vegetable	/	/	Vegetable
Tebuconazole	Vegetable	/	Vegetable	Vegetable
Thiophanate-methyl	/	/	/	Vegetable
Triadimefon	Vegetable	/	/	/
Trifloxystrobine	/	/	Vegetable	Vegetable

Nematicides

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

6. Regulations and pesticide residues

Status of the active substances in Regulation 1107/2009; European MRL and Codex MRL in May 2015

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

Active substance	European regulation		Codex MRL
	Status Reg 1107/2009	MRL	
Abamectin	Approved	0.02	/
Acetamiprid	Approved	0.2	0.2 fruiting vegetable except cucurbits
Alpha-cypermethrin	Approved	0.5	0.03
Azadirachtin	Approved	1	/
Azoxystrobin	Approved	3	3 fruiting vegetable except cucurbits
Bacillus thuringiensis	Approved	/	/
Beta-cyfluthrin	Approved	0.1	0.2
Bifenthrin	Approved	0.3	0.3
Boscalid	Approved	3	3 fruiting vegetable except cucurbits
Cadusafos	Not approved	0.01**	/
Carbendazim	Not approved	0.5	/
Carbofuran	Not approved	0.01**	/
Carbosulfan	Not approved	0.01**	/
Chlorantraniliprole	Approved	0.6	0.6 fruiting vegetable except cucurbits
Chlorothalonil	Approved	6	/
Chlorpyrifos-ethyl	Approved	0.5	/
Chlorpyrifos-methyl	Approved	0.5	1
Copper	Approved	5	/
Cymoxanil	Approved	0.05	/
Cypermethrin	Approved	0.5	0.03
Deltamethrin	Approved	0.3	/
Difenoconazole	Approved	0.4	/
Diflubenzuron	Approved	0.05	/
Dimethoate	Approved	0.02**	/
Emamectin benzoate	Approved	0.02	0.02 fruiting vegetable except cucurbits
Ethoprophos	Approved	0.02**	/
Fatty acids	***	No MRL required	/
Flubendiamide	Approved	0.2	/
Fosetyl-Al	Approved	100	/
Imazalil	Approved	0.05**	/
Imidacloprid	Approved	0.5	0.2
Indoxacarb	Approved	0.5	0.5

Active substance	European regulation		Codex MRL
	Status Reg 1107/2009	MRL	
Iprodione	Approved	5	/
Lambda-cyhalothrin	Approved	0.5	0.3 fruiting vegetable except cucurbits
Malathion	Approved	0.02**	/
Maltodextrin	Approved	No MRL required	/
Mancozeb	Approved	3	/
Metalaxyl-M	Approved	0.05**	/
Methomyl	Approved	0.02**	/
Myclobutanyl	Approved	0.3	/
Oxamyl	Approved	0.02	/
Oxymatrine	Not listed	Non listée	/
Pencycuron	Approved	0.05**	/
Petroleum oil	***	0.01*	/
Pirimicarb	Approved	1	0.5 fruiting vegetable except cucurbits
Propamocarb HCl	Approved	10	0.3
Propiconazole	Approved	0.05**	/
Propineb	Approved	3	/
Pyraclostrobin	Approved	0.3	0.3
Pyrethrin	Approved	1	/
Spinosad	Approved	1	/
Spirotetramate	Approved	0.5	1 fruiting vegetable except cucurbits
Sulfur	Approved	No MRL required	/
Tebuconazole	Approved	0.4	0.1
Tetradifon	Not approved	0.01*	/
Thiacloprid	Approved	0.5	0.7
Thiamethoxam	Approved	0.2	0.7 fruiting vegetable except cucurbits
Thiophanate-methyl	Approved	2	/
Thiram	Approved	0.1**	/
Triadimefon	Not approved	1	1 fruiting vegetable except cucurbits
Trifloxystrobine	Approved	0.7	0.7

Approved: active ingredient approved for use in EU countries
Not approved: active ingredient not approved for use in EU countries; but could be used in countries out of EU if the EU LMR are respected for the imported products in EU
* = default value
** = LOQ value
*** = status depend on the type. See http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection&language=EN to know which ones are approved
/ = no MRL or LOQ value available

Note on the status of active substances in EU

Before a Plant Protection Product can be marketed in EU, its active substance must be approved by the European Commission. Regulation (EC) 1107/2009 (replacing former "Directive 91/414/EEC") came into force on 14th June 2011. By 25th May 2011 the Commission adopted the Implementing Regulation (EU) N° 540/2011 as regards the list of approved active substances. These Regulations and all other related Regulations can be accessed using the search facility on the following: http://ec.europa.eu/food/plant/pesticides/index_en.htm. Current status of active substances can be checked at http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection&language=EN .
It should be noted that if an active substance is not registered in the EU it can still be used in the ACP countries in food items exported to Europe, provided the residue complies with the EU MRL.

Note on MRLs:

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

MRLs in the EU

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

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

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

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

EU harmonized MRLs came into force on 1 September 2008 and are published in the MRL database on the website of the Commission
http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=pesticide.residue.selection&language=EN

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

How are MRLs applied and monitored in EU?

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

MRLs in ACP countries – Codex

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

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

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

Annexes

References websites and useful documents

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Dobson, H *et al* (2002) Integrated Vegetable Pest Management. Safe and sustainable protection of small-scale brassicas and tomatoes. Pub. Natural Resources Institute, UK.

Miller, S et al. Fusarium and Verticillium Wilts of Tomato, Potato and Eggplant. Pub Ohio State Uni.

Pandey, B.P, (2001), *Plant Pathology, pathogen and platn disease*. Pub. S.Chand & Company Ltd, New Delhi.

Picker, M et al (2002) Field guide to insects of South Africa. Struik, South Africa

Talekar, N.S (2003) Harmful and Helpful insects in eggplant fields. Pub. AVRDC

Whitehead, R (Editor) (2006) The UK Pesticide Guide 2006 Pub. CABI Publishing

General information

http://www.bspp.org.uk/ndr - Reports on New diseases identified for various crops.
http://plant-disease.ippc.orst.edu - Fact sheets on various diseases
http://www.ipm.ucdavis.edu - UC Pest management guides
http://plant-disease.ippc.orst.edu - Online Guide to Plant Disease Control

Mating disruption references

http://www.insectsciences.za - Suppliers of “Last call” products to attract male moths and kill them to disrupt mating.
http://www.exosect.co.uk - Mating disruption products.

CROP PRODUCTION PROTOCOLS

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

GUIDES TO GOOD PLANT PROTECTION PRACTICES

Amaranth (*Amaranthus* spp.)
Baby carrot (*Daucus carota*)
Baby and sweet corn (*Zea mays*)
Baby Leek (*Allium porrum*)
Baby pak choy (*Brassica campestris* var. *chinensis*), baby cauliflower (*Brassica oleracea* var. *botrytis*), baby broccoli and sprouting broccoli (*Brassica oleracea* var. *italica*) *and head cabbages* (*Brassica oleracea var. capitata* and *var. sabauda*)
Banana (*Musa* spp. – plantain (*matoke*), apple banana, red banana, baby banana and other ethnics bananas)
Cassava (*Manihot esculenta*)
Chillies (*Capsicum frutescens, Capsicum 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 (*Ipomoea batatas*)
Tamarillo (*Solanum betaceum*)
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)

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