PIP

GUIDE TO GOOD PLANT PROTECTION PRACTICES

FOR DASHEEN (*COLOCASIA ESCULENTA*) AND MACABO (*XANTHOSOMA SAGITTIFOLIUM*) IN ACP COUNTRIES

PIP

FOR SUSTAINABLE DEVELOPMENT OF
THE ACP HORTICULTURAL INDUSTRY

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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Notice

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, to be replaced by Regulation 1107/2009 from 14 June 2011, 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. Howhever information given on the active substances suggested is 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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FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

Table of contents

1. Main enemies and significance

This guide deals with the plant protection of taros/macabos. These two crops are grown for their underground tubers (called corms in Araceae). In some countries, the young leaves are also consumed in the form of brèdes (greens). There is often a great deal of confusion in the nomenclature of these plants which, according to the country, have a variety of local names, the same name or a similar name that might denote different species in two countries.

In regard to **taros/macabos**, the diversity of names is even larger. Two main species from the family Araceae are grouped together under this nomenclature. The most common are listed in the table below:

Species Botanical name	Main area of cultivation	Most common vernacular names
Colocasia esculenta var. *escuelenta* This is the "dasheen" type cultivated for its primary corms	South-East Asia, Brazil, Oceania, Central America and the Caribbean	Taro, dasheen, old cocoyam (Anglophone African and Pacific countries), malanga (Latin America), madère (Guadeloupe), chouchine or dachine (Martinique/Guyana), inhame (Brazil)
Colocasia esculenta var. *antiquorum* "Eddoe" type cultivated for the secondary corms. Eddoes are adapted to cooler climates and high latitudes	Japan, Brazil	Eddoe, Japanese taro, ñampi (Central America), madère (French West Indies), songe maurice (Réunion) bourbon taro (New Caledonia)
Xanthosoma sagittifolium (syn. *X. violacea* with purple flesh).	Central America, Guyana, the Caribbean, Ghana, Cameroon, East Africa	New cocoyam, tania, tannier, yautia, macabo (Cameroon), inhame/taioba (Brazil), taïobe (Guyana), songe (Réunion), chou caraïbe (Martinique).

1.1 Extent and impact on the quantity and quality of the production

The forms given below show the list of the main pests and diseases that will be dealt with in this guide. For each pest/disease, the following is given:

- The level of significance of the economic impact generally observed in ACP countries according to the following scale:
  (+) insignificant, (++) quite significant, (+++) significant.
- The parts attacked on the plant.
- The type of losses sustained that are responsible for yield losses of marketable tubers which thereby results in economic losses for those involved in the industry.

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

INSECTS						
Importance	Organs affected		Type of losses			
	Leaves	Corms	Number of plants	Number of corms per plant	Size/weight of the corms	Quality of the corms
Hemiptera **Cotton/melon aphid: *Aphis gossypii* (Aphididae)** **Attacks taro (*Colocasia*) and macabo *(Xanthosoma)***						
	Virus vector potential					
+	Outbreak on the underside of the leaves			Decreasing because of weakening of plants due to downward wilting and curling of leaves		
Sweet potato/tobacco/cotton whitefly (*Bemisia tabaci, B. argentifolii*) on taro (*Colocasia*) and macabo (*Xanthosoma*)						
	Virus vector potential					
+	Outbreak on the underside of the leaves			Decreasing because of weakening of plants due to downward wilting and curling of leaves		
Taro leafhopper (*Tarophagus Proserpina*): Delphacidae - Feeds only on taro (*Colocasia*)						
	Vector of the Alomae Bobone Virus Complex (ABVC)					
++	Larvae and adults congregate on the underside of leaves. They suck the sap			Decreasing because of weakening of plants due to wilting of leaves		
Coleoptera						
Taro beetle *(Papuana* spp.*):* Scarabaeidae, *Papuana woodlarkiana, Papuana biroi, Papuana huebneri,* et *Papuana trinodosa*						
+++		The adult bores out galleries. The larvae feed on the roots				Decline in the quality due to galleries
Lepidoptera						
Taro hawkmoth/hornworm *(Hippotion celorio), Sphingidae*, feeds on the majority of plants from the taro family *(Araceae)*						
+	The caterpillars eat the blade		Young plants may die if heavy attack	Decreasing due to weakening of plants		
Cluster caterpillar or Armyworm *(Spodoptera litura* QO*):* Noctuidae						
+	The caterpillars eat the blade and can also cut off young plants at ground level		Young plants may die if heavy attack or if the stem is cut	Decreasing due to weakening of plants		

Importance	Organs affected		Type of losses			
	Leaves	Corms	Number of plants	Number of corm per plant	Size/weight of the corms	Quality of the corms
NEMATODES						
Root-knot nematodes: *Meloidogyne* spp.						
+		Larvae enter in corms after eggs hatching in the soil		Low impact		Decrease in commercial value due to deformations
Root Lesion Nematodes: *Pratylenchus coffea*						
+		Larvae enter in corms after eggs hatching in the soil				Decrease in commercial value due to symptoms
FUNGI						
Taro leaf blight (*Phytophthora colocasiae*) QO on taro (*Colocasia*), macabo (*Xanthosoma*) is not attacked						
+++	Development of mycelium in spots on the blades		Destruction of the plants	Decreasing if heavy attack and non-resistant variety		Rot may occur
Ghost/False spot: *Cladosporium colocasiae*						
+	Development of mycelium on the blades				Decreasing if heavy attack	
Corm soft rot - *Pythium* spp. - Mainly on Macabo						
+++		Soil-borne, and spread by hydromorphy. Rotting of corms		Plant stunted if not destroyed		Poor preservation. Soft and malodorous flesh
Corm and leaf rot - *Marasmiellus stenophuyllus*						
+	Mycelium attacks the collar			Decreasing due to weakening of plants		
VIRUS						
Alomae Bobone Virus Complex: at least 2 viruses are involved Taro Large Bacilliform Virus (TLBV) transmitted by the leafhopper *Tarophagus proserpina* and Taro Small Bacilliform Virus (TSBV) transmitted by the *mealybug Planococus citri*						
++	The whole plant is invaded after transmission by the vector		Plants are stunted then die	Up to a 25% yield loss due to weakening of plants		
Taro mosaic virus: Dasheen Mosaic Virus Disease (DMV), transmitted by aphids on taro and macabo						
++	The whole plant is invaded after transmission by the vector			Reduction due to stunting		

1.2 Identification and damage

This section contains information and illustrations to facilitate the identification of the main pests and diseases.

INSECTS

Biting insects - Aphid: *Aphis gossypii* - Whiteflies: *Bemisia tabaci, B. argentifolii, Aleurodicus dispersus*

The aphids prefer the under side of leaves but the whole plant may be covered in the case of a severe attack. They cause withering of the leaf blade and downward shrivelling as well as a generalised weakening of the plant in the case of severe attacks.


Whiteflies


Aphids

Taro leafhopper: *Tarophagus proserpina*

Larvae and adults gather on the underside of leaves (*Colocasia* only) and suck the sap, which runs and causes reddish scale on the blade and brown/black spots on the leafstalks. The adults measure 3 to 5 mm in length and are black with a whitish stripe running lengthways.


Spots on the leafstalks


Leafhoppers

Defoliating caterpillars - Armyworm: *Spodoptera litura*

Young caterpillars (2-10 mm) are pale green and become dark green to brown when fully grown. They have characteristic bright yellow stripes running lengthways on their back. The moth is nocturnal and its body is brownish-green, measuring 15 to 20 mm with a wingspan of 30 to 40 mm. The larvae are gregarious in their early stages, with radical progression from the hatching site. Afterwards, the caterpillars become solitary and eat all parts of the leaf blade, sometimes cutting the leafstalks at ground level.


Caterpillar


Damages on a leaf

Taro hawkmoth/hornworm: *Hippotion celerio*

The larvae possess a red sting on the posterior part of the abdomen. Measuring only a few mm with a pale yellow body, they become bright green and then dark brown when fully grown, reaching 8 to 9 cm prior to pupation. The moth has a wingspan of 4 to 9 cm. In the case of caterpillar infestation, defoliation may be severe.


Caterpillar


Damages on a leaf

Taro beetle: *Papuana spp.* of which *Papuana woodlarkiana, P. biroi, P. huebneri, P. trinodosa*

The beetles measure 25 mm in length and are half as wide. Males have a horn on the head with a bulge at the base. Females sometimes have smaller versions of these attributes. The body is dark brown and very shiny during the first months. Damage is caused by adults which bore into the corms.

Adult

Damages on a corm

Papuana: various stages

NEMATODES

Rootknot nematode - *Meloidogyne* spp.

Meloidogynes cause rather discreet damage to taro with limited bulging of roots and negligible galls for the most part.

Symptoms on a corm

Root lesion nematodes - *Pratylenchus coffeae*

This very cosmopolitan and polyphagous nematode causes necrosis on roots and in corms, thus reducing their commercial value. Attacks are more frequent with repeated use of the same plots. In the field, the attacks are often confined to precise rows or areas where the plants show signs of withering and obvious reduction in growth compared with unharmed areas.

Necrosis on roots

Irregular growing

DISEASES

Taro leaf blight: *Phytophthora colocasiae*

The first visible signs of this fungus are small circular light brown spots which appear dry on the top of the leaves and wet underneath. The spots generally begin on the parts of the blade where water collects. The spots then spread in an irregular shape and become darker with yellow edges.


Spots on leaf


Spots on leaf

Taro leaf spot or mould: *Cladosporium colocasiae*

This fungus causes circular spots on old leaves which soon become blemished on the opposite side. The centre of the spots is light and the edges are very black.
On older leaves it is often associated to another fungus (*Pseudocercospora colocasiae*) which induces similar symptoms.


Brown edge on a leaf


Brown circular spots

Root rot - *Pythium* spp.

This fungus attacks the roots, especially in hydromorphic soil. Macabo (Xanthosoma) is particularly sensitive but taro can also be affected. On the parts above ground, withering and stunting of leaves, shortening of leafstalks and chlorosis of the blade (greenish-yellow colour) may be noticed. When an affected corm is cut, the diseased parts are faded and soft with a marked separation from healthy areas, which remain white or coloured, depending on the cultivar. The healthy roots are cream or rose coloured and turgescent, whereas the diseased roots are dark and flaccid before complete necrosis.


Damages on collar and leaf stalks


Wilting

Corm and leaf rot - *Marasmiellus stenophuyllus*

Marasmiellus attacks taro plants at the neck causing a withering of leaves, corms and roots. The leaves wither due to the development of large areas of brown rot. They often remain clustered due to the development of a mycelium thread. The dead plants appear mummified. The fungus kills the roots which remain attached to soil particles. A characteristic symptom is the appearance of many carpospores on damaged parts at ground level.


Mummifies appearance of a plant


Carpospore at ground level

Alomae/Bobone viral complex

The symptoms of these viral diseases can vary greatly according to the situation and taro variety. In the case of Bobone and certain Alomae, the leaves become stunted, dark green and crumpled, sometimes on only one part of the blade, or are improperly unfolded. In other cases of Alomae, entire plants can take on a shrivelled appearance, with the blade drooping at the tip of the leafstalk. In all cases, the plants die quickly and the leaves wither and close up. Entire plants become necrotised and die.


Loss of plants


Various symptoms


Various symptoms


Various symptoms

Taro mosaic: Dasheen Mosaic Virus Disease (DMV)

Plants infected with DMV show a wide variety of mosaic types: small, irregular and sparse, with spots ranging from green to yellow, grey or white, in the shape of a feather on either side of the main veins. Generally the plants overcome these attacks and regain a normal appearance, but some severe attacks from which plants have not recovered have been reported.


Various symptoms


Various symptoms


Various symptoms


Various symptoms

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

The following tables show 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.

The life cycle of dasheen is more or less 9 to 10 month from planting to harvest. At room temperature conservation of corms cannot exceed some weeks. For market reasons the harvesting period can be spread out for 2 to 3 months from the sixth month. These values depend obviously on cultivars and growing conditions. The life cycle of macabo (*Xanthosoma*) is a bit longer (9-12 months) and vary in accordance with the same factors. Postharvest conservation being short, postharvest disease are usually of minor importance.

Stage of the crop	Start and end of the stage (approx.) in weeks after planting	*Aphis gossypii* *Bemisia tabaci*		*Tarophagus proserpina*		*Spodoptera litura* *Hippotion celerio*		*Papuana* spp.		*Meloidogyne* spp. *Pratylenchus coffeae*		*Phytophthora colocasiae*		*Cladosporium colocasiae*		*Pythium* spp.		*Marasmiellus stenophuyllus*		Complexe viral - Alomae/Bobone		Taro mosaic (DMV)	
Cuttings	-																						
Emergence	8 -10 after planting																						
Foliar development	10 to 25-30																						
Corms growtrh	25-30 to 40-50																						
Senescence of aerial organs	30 to 50																						
Harvesting	-																						
Storage of tubers	2 to 3 *																						

* stage length in weeks

Periods during which pest or pathogenic agent is potentially present.

Periods during which the appearance of a serious infestation can cause the greatest loss.

1.4 Importance by country – periods of the year and climate conditions favourable to crop enemies

UGA = Uganda, GHA = Ghana, JAM = Jamaica, 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.

Aphid - *Aphis gossypii*

Favourables conditions: Low hygrometry and high temperatures.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Whitefly - *Bemisia tabaci*

Favourables conditions: Low hygrometry and high temperatures.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Taro leafhopper - *Tarophagus proserpina*

Favourables conditions: Dry season.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Taro beetle - *Papuana* spp.

Favourables conditions: Humid soil.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Taro hawkmoth/hornworm - *Hippotion celerio*

Favourables conditions: No information available.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Defoliating caterpillars, Armyworm - *Spodoptera litura*

Conditions favorables : Outbreaks are obseerved after cyclones (destruction of natural ennemies).

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Root-knot nematodes - *Meloidogyne* spp.

Favourables conditions: Humid soil without excess.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Root Lesion Nematodes - *Pratylenchus coffeae*

Favourables conditions: No information available.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Taro leaf blight - *Phytophthora colocasiae*

Favourables conditions: Temperature 25-28°C and humidity 60-70 % during the day, cool nights (20-22°C) and very humid. Weak rainfall or heavy dew in the morning favour dispersal of the disease.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Ghost spot - *Cladosporium colocasiae*

Favourables conditions: Humid and high altitude area.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Corm soft rot - *Pythium* spp.

Favourables conditions: On taro high temperatures, very humid soils. On macabo water in excess in the soil favour the disease.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Corm and Leaf Rot - *Marasmiellus stenophuyllus*

Favourables conditions: No information available.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Alomae/Bobone viral complex

Favourables conditions: No information available.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

Taro mosaic - Dasheen Mosaic Virus Disease (DMV)

Favourables conditions: Heavy aphids infestation favoured by a high humid heat.

Month	1	2	3	4	5	6	7	8	9	10	11	12
UGA	/	/	/	/	/	/	/	/	/	/	/	/
GHA	/	/	/	/	/	/	/	/	/	/	/	/
JAM	/	/	/	/	/	/	/	/	/	/	/	/
DOR	/	/	/	/	/	/	/	/	/	/	/	/

2. Main control methods

2.1. Introduction

Dasheen and macabo are tropical plants adapted to hot, humid climates. Below 20°C, growth slows. These plants reproduce via vegetative multiplication, which in agriculture is done by replanting part of the vegetative body, bypassing the production of seeds. Growers use cuttings which are heads of corms with the central bud or small tubers for antiquorum dasheen type (eddoe) as well as for macabo (*Xanthosoma*).

From a health point of view, the cuttings are possible carriers of practically all pests and diseases. The choice and preparation of planting material is therefore extremely important for maintaining the crops in a satisfactory state of health. When the necessary precautions are not taken, very quickly in a few generations there will be a high pest and disease load, particularly nematodes and viruses.

In traditional food crop systems, the growing techniques used minimize the risks of proliferation: slash and burn cultivation, long fallow periods, sometimes intervals of several decades before recultivation, isolation and small size of fields. In traditional plots there is generally strong agro-biodiversity (inter- and intra-species) – i.e. a mix of several cultivated species, with each species having several varieties, often with different behavior (resistance to disease, cycle, etc). These conditions slow the multiplication and dissemination of pests and pathogens.

When cultivation becomes more intensive, with shorter fallow periods, planting of larger plots and weaker genetic diversity, pressure from pests and diseases increases. If the planting material is not se-lected and produced cautiously, the health of the crops can deteriorate significantly, compromising the profitability and even the preservation of these crops. While in the major producer countries potato seeds undergo a specific multiplication process which is extremely meticulous and carefully separated (including geographically) from the production itself, to avoid the proliferation of viruses and other pathogens, with dasheen and macabo the planting material is generally produced by the farmers themselves, simply by selecting cuttings from their own yield. Under these conditions it is even more important to use good agricultural practices (crop rotation, elimination of unhealthy plants, rigorous selection of cuttings and seeds, preservation of strong agro-biodiversity, etc) to minimize the health risks.

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

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

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

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

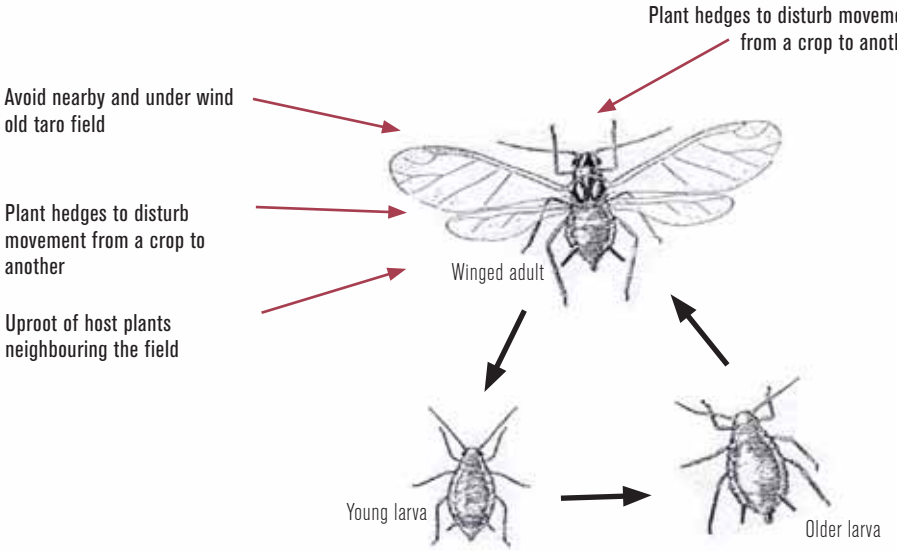
- Cultivation practices.
- Application of plant protection product.

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

APHID - *APHIS GOSSYPII*

Positioning of control methods in terms of the development cycle 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 natural enemy insects (ladybirds, syrphus flies), specific insecticides should be chosen.



To control all stages

- Natural heavens to encourage natural enemies e.g. beetles and hoverflies, *Aphidius*
- Use of selective insecticides: soap solutions, neem products
- Sprinkler irrigation, strong rain
- Destruction of infested leaves after harvesting
- Control ants in the field, as these will disrupt natural enemy activities

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

Choice and preparation of the field

- Provide hedges to limit movements of aphids from a crop to another and to encourage natural enemies.
- Avoid nearby and under wind old taro field.
- Uproot of host plants neighbouring the field.

After planting

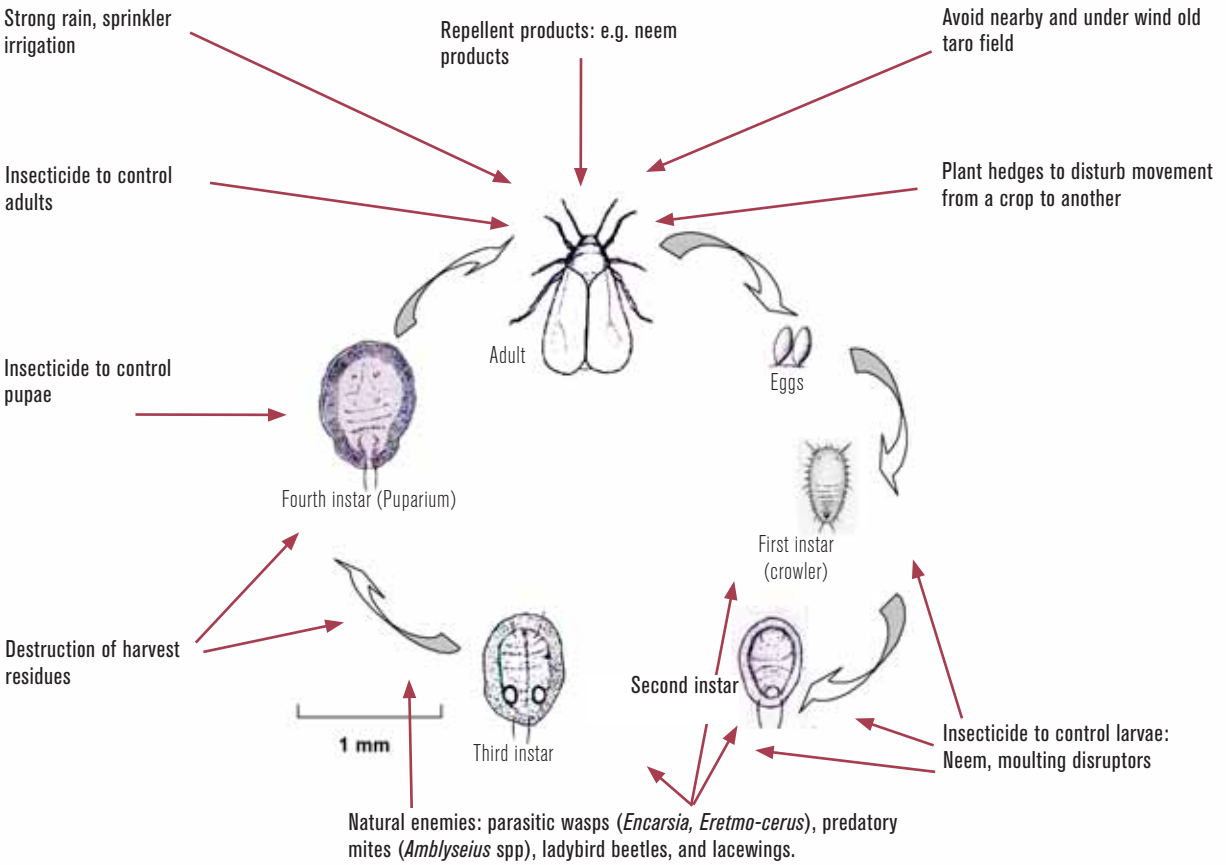
- Sprinkler irrigation or sustained rain can reduce infestation.
- Control ants in the field, as these will disrupt natural enemy activities.
- Treatment with selective insecticides.

After harvesting

- Destruction of infested leaves after harvesting.

WHITEFLIES - *BEMISIA TABACI, B. ARGENTIFOLII, ALEURODICUS DISPERSUS*

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

Choice and preparation of the field

- Provide hedges to limit movements of whiteflies from a crop to another and to encourage natural enemies.
- Avoid nearby and under wind old taro field.

During the production cycle

- 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 natural enemies) used alternately (to limit the risks of resistance) to control adults.
- Encourage natural enemies: *Encarsia formosa* and others.

After last harvesting

- Destruction of harvest residues to prevent buil up and spreading.

Taro leafhopper - *Tarophagus proserpina*

Major elements of the control strategy:

Development stages of the pest	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Egg	Remove the base of the leafstalk on the cuttings, as they often contain hidden leafhopper eggs.			X					
	Use of the biological control method with *Cyrtorhinus fulvus* *.				X				
Larva, adult	In the event of heavy infestation, carefully apply an insecticide.				X				

X = action to be taken at the cultivation stage shown in the corresponding column.
* see part 2.4. of the guide.

Armyworm - *Spodoptera litura*

Major elements of the control strategy:

Development stages of the pest	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Egg	Encourage the development of the natural enemies by planting *Coleus blumei* in the taro fields, a plant, whose nectar and pollen attract adult parasitoids*.	X	X	X					
Caterpillar	Destruction of the taro leaves infested by the pest (eggs and caterpillar) in the neighbouring plots and crops after harvesting.				X				
	In the event of heavy infestation, treat with an insecticide.			X	X				

X = action to be taken at the cultivation stage shown in the corresponding column.
* see part 2.4. of the guide.

Taro hawkmoth/hornworm - *Hippotion celerio*

Major elements of the control strategy:

Development stages of the pest	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Caterpillar	As the caterpillars are large (8-10 cm), they can be easily removed by hand on small surfaces.				X				
	If biological control methods are used, several known predators have been identified for inundative releases*.			X	X				
	In the event of heavy infestation, spray insecticides.				X				

X = action to be taken at the cultivation stage shown in the corresponding column.
* see part 2.4. of the guide.

Taro beetle - *Papuana* spp.

Major elements of the control strategy:

Development stages of the pest	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Larva	Use clean cuttings (without soil residue).			X					
	Biological control with entomopathogenic fungus: *Metarhizium anisopliae.*								
Larva Adult	Localised application of insecticides in combination with the other control methods.			X	X	X			
All the stages	Rotation: do not repeat the crop.	X							
	Cleaning fallow based on *Glycine wightii* for 2 years.		X						
	Avoid planting next to areas conducive to the reproduction of the beetle: forest clearing, close to river banks, tree stumps.	X							

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

Root-knot Nematodes - *Meloidogyne* spp.
Root Lesion Nematodes - *Pratylenchus coffeae*

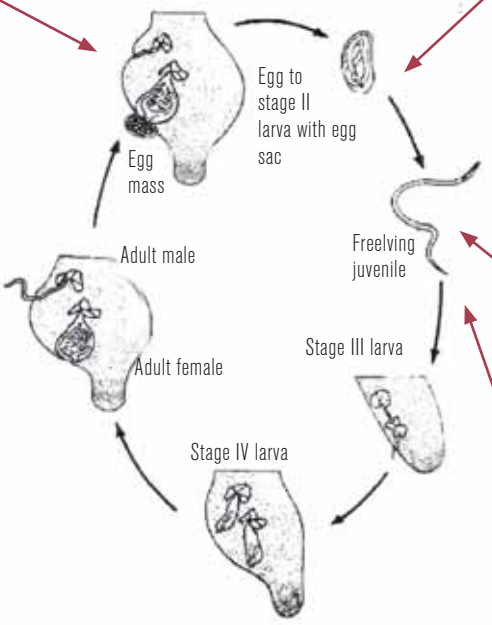
Positioning of control methods in terms of the development cycle of the pest

Biopesticides:
Pæcilomyces,
Bacillus subtilus
Pasteuria penetrans

Select cuttings: avoid those originating from infected plots, wash them accurately to avoid presence of soil that could bring nematodes

Ploughing with solarization

Plant 'nematocide' plants as part of crop rotation:
- tagetes – kill young nematodes
- crotalaria – non-host plant



<u>To fight against pests and diseases at every stage</u>

- Remove and destroy waste from the field immediately after harvest to avoid increasing the populations in the field.
- Remove infected plants and weeds.
- Rotation: avoid host plants.

Apply compost or manure to impede the movements of juveniles and reinforce the activity of natural enemies and humic acid on nematodes

Nematocides: only for seed production; prohibited on crops producing tubers for consumption

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

<u>Before preparing the ground</u>

- Rotate crops, avoiding cultivating yams two years in a row. Avoid first crops encouraging the development of nematodes (mainly *solanaceae* for *Meloidogyne*).
- Plant cover crops with a nematode suppressant/nematocide effect as a first crop, enabling the reduction of nematode populations in the soil. A number of plant species with a nematocide effect may be recommended but must be validated locally since their antagonist action is often limited to certain species of nematode (*Meloidogynes* or *Pratylenchus*) and their effectiveness also depends on the variety of plant species used.

Species available as a first crop with nematode-suppressant action.

Scientific name	French/English name	Remarks
1. *Tagetes erecta* 2. *T. patula* 3. *T. minuta*	1. Tagète africaine/African marigold 2. Œillet d'Inde/ french marigold 3. Tagète des parfumeurs / mexican marigold *	Cover crop as first or associated crop * notably the Nemanon® variety
Arachis hypogea	Arachide/groundnut	Crop
Cajanus cajan	Pois d'angol/pigeon pea	Crop
Calopogonium sp.	*Calopogon* sp.	Cover crop, leguminous
Crotalaria juncea	Crotalaire/Crotalaria	Cover crop. Strong action against *Pratylenchus coffea* as first crop or associated crops
Macroptilium atropurpureus	Siratro	Cover crop, leguminous, antagonist of *Meloidogyne* sp.
*Mucuna atterrima (*syn. *Styzolobium atterrimum)*	Mucuna noire/black mucuna	Cover crop
Panicum maximum var. *trichoglume*	Herbe de Guinée/ Guinea or Buffalo grass	
Sesamia indica	Sésame/sesame	Crop
Vigna unguiculata	Niébé/cowpea	Crop

Cover crops may be used as fallow crops cultivated in a mixture (cocktail) or as a pure crop. The cocktail has the benefit of a broader spectrum anti-nematode effect. The disadvantage is that it is more difficult to manage, to avoid a natural self-sowing of the seeds of the different species with different cycles.
A pure crop avoids these disadvantages if cutting is done before seed production, but the spectrum of antagonist action on nematode species is more narrow. The crop must be cut before seeds are produced and buried in the soil.

When preparing the ground

- Ploughing with solarisation (sterilisation of the soil under the effect of the sun's rays) under transparent plastic sheet; disinfection of the soil with steam may, on restricted surfaces, constitute an adapted solution to limit nematode populations in plots of land.
- An increase in the organic matter content via manure or compost helps to limit nematodes.

At planting

- Rigorous choice of seeds. Eliminate all contaminated material (nematode galls, lesions or splits).
- Apply nematocides by dipping tubers and as soil treatment when planting for seed production only.

Throughout the plant cycle

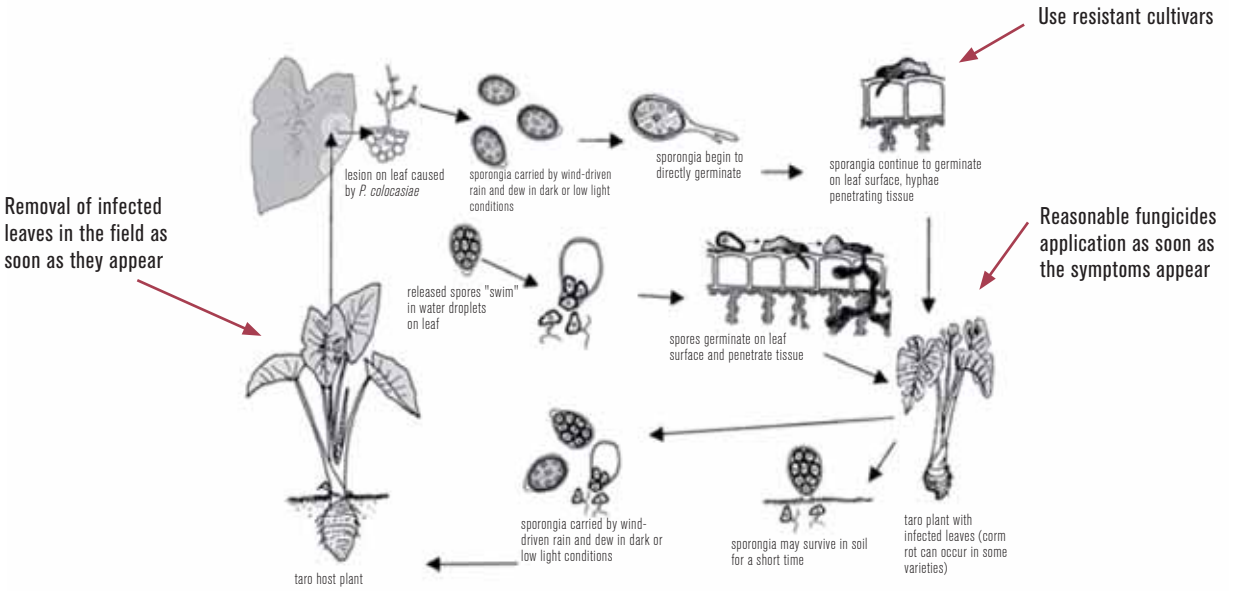
- Eliminate weeds – potential hosts for nematodes.

After the harvest

- Sort and separate the infected tubers from those that appear healthy. Keep them separate.

Taro leaf blight - *Phytophthora colocasiae*

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



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

Choice of the plot before planting

- Choose plots that are isolated from other taro fields, if possible surrounded by high vegetation (forest clearing, etc.).
- When the plots are close, synchronise the taro planting dates if possible, which prevents the young plants from being contaminated by affected plots that represent a significant stock of inoculum.

At planting

- Use cultivars that are resistant to the *Phytophtora* obtained from varietal selections or creations carried out by agronomic research. Resistant material can be obtained in particular from the Regional Germplasm Centre of the Pacific Community based in Fiji.
  Contact: RGCcurator@spc.int.

For all international exchange of genetic material, it is compulsory to respect the international rules governing the protection of genetic resources laid down in the International Treaty on Plant Genetic Resources for Food and Agriculture of the FAO.
See: http://www.planttreaty.org/.

Throughout the plant cycle

- Remove the diseased leaves as soon as the symptoms of wilting appear and burn them. To do so, it is necessary to regularly inspect the plots, in particular 3 to 4 days after strong rainfall or in the event of morning dew.
- Apply fungicides on the leaves by spraying as soon as the symptoms appear and following the removal of the attacked leaves.

After the harvest

To avoid rotting due to the *Phytophtora* (and to the *Pythium*), the corms will be treated before being put on the market by soaking them in a solution with a 1% bleach (sodium hypochlorite) content for 2 minutes. Dry well before packing in a polyethylene bag.

Ghost spot - *Cladosporium colocasiae*

Major elements of the control strategy:

Development stages of the fungus	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Symptoms development	Removal and burning the leaves affected.				X	X	X		

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

Corm soft rot - *Pythium* spp.

Major elements of the control strategy:

Development stages of the fungus	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Germination on the plant	Avoid saturated or badly drained soil.	X							
	Plant on balks (macabo).		X						
	Fungicide application.			X	X				
Development on the plant	Use of healthy cuttings.			X					
	Use of tolerant cultivars.			X					
	Fungicide application.				X	X			
	Disinfection of the corms before packing through soaking.							X	
Conservation in the soil	Former banana plantations offer favourable conditions to control the disease.	X							

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

Corm and Leaf Rot - *Marasmiellus stenophuyllus*

Major elements of the control strategy:

- Essentially prophylactic measures through the destruction of the plants and the burning of the infected plants to avoid the dissemination of the mycelium.

Development stages of the fungus	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Conservation in the soil	Avoid the precedents of the same crop, rotation.	X							
Production of spores	Destruction of the infected plants.				X	X	X	X	

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

Viral diseases: Alomae/Bobone, DMV, ...

Major elements of the control strategy:

Development stages of the fungus	Action	Cultivation stages							
		Choice of parcel	Preparation of parcel	Planting and germination	Leaves growing	Corms development	Senescence of aerial organs	Corms harvesting	Corms storage
Inoculation by the vector	Isolated and protected plots (clearing).	X							
Absorption by a vector	Removal of diseased plants by burning or burying.				X	X	X		
Transfer from one field to another	Use of cuttings from healthy mother plants*.			X					

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

* International exchanges must follow strict sanitary measures and shall only be done using in vitro plant material indexed and certified virus-free.

2.3 Importance and use of natural enemies

- The use of biological control methods with *Cyrtorhinus fulvus*. See part (Hemiptera: Miridae), predator of the leafhopper eggs, has given good results in the Pacific against the *Tarophagus proserpina* leafhopper.
- Examples of natural enemies of the *Spodoptera litura*:
  - egg parasite: *Telenomus nawaii* (Hymenoptera: Scelionidae);
  - caterpillar parasite: *Apanteles marginiventris* (Hymenoptera – Braconidae), *Peribaea orbata* (Diptera: Tachinidae), *Chelonus* sp. (Hymenoptera: Braconidae), *Palexorista* sp. (Diptera: Tachinidae) and others...
- Favour the development of natural ennemies through the planting in the taro fields of *Coleus blumei*, a plant whose nectar and pollen attract adult parasitoids.

Coleus blumei

- Against the taro sphinx, use of the micro-wasp (8-10 mm) *Trichogramma chilonis*, (Hymenoptera: *Trichogrammatidae*) used to protect sugar cane.
- Against the taro beetle, biological control with entomopathogenic fungus: *Metarhizium anisopliae*.
- Biological control of *Meloidogyne* spp.: possible if commercial strains are available: for example, the bacterial hyperparasite *Pasteuria penetrans* and the fungus *Paecilomyces lilacinus* (for example strain 251).

3. Active Substances and Treatment Recommendations

Introduction

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

A list of active substances is suggested for each pest or disease. When available, the critical GAP is also given.
The PHI (Pre-Harvest Intervals) are also indicated for:
- either to comply to the European MRL (for foodstuffs exported to EU) ;
- or to comply to the Codex MRL (for foodstuffs marketed in countries which refer to the Codex MRLs) ;
- or to produce without quantifiable residues and so respond to « 0 » residues requirements of some private standards.

Any change in one or more elements of these GAPs (increase in the 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 in 2009 under tropical conditions by PIP on dasheen in Dominican Republic.

For active substances not tested in ACP growing conditions, when leaves are produced for consumption it is better to not apply PPP on the foliage since PHI to respect is not known on this crop.

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 . . .), wood ash (to combat aphids, post-harvest rotting...) and soap solutions (to control aphids. . .). 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. . .) also exist and are not listed in the following tables because they pose no problems in terms of residues.

PIP quarterly updates on its website a compilation of the GAPs (Good Agricultural Practice) taking Into account modifications of EU and Codex MRLs.

Aphid - *Aphis gossypii*
Whiteflies - *Bemisia tabaci, B. argentifolii, Aleurodicus dispersus*
Taro leafhopper - *Tarophagus proserpina*

Strategy : In case of heavy infestation, treat aerial parts of the plant combining chemical pesticides with oils and soaps

Active substance	Recommended GAP*									Proposed application period			
				Pre-harvest interval (days) for corms production			Pre-harvest interval (days) for leaves production						
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ	Soil preparation	Cuttings	Foliar development	Harvest and storage
Group 3 – Pyrethroids													
Cypermethrin	70	2	14	15	15	15	**	**	**				
Deltamethrin	12 .5	2	14	15	15	15	8	8	8				
Group 1 – Organophosphates and carbamates													
Dimethoate	400	2	14	/	/	/	/	/	/				
Pirimicarbe - (to control aphids)	250	2	/	/	/	/	/	/	/				
Group 9													
Pymetrozine - (to control aphids and whiteflies)	200***	2	14	30	30	30	30	30	30				
Groupe 4 - activité agonistique sur le récepteur nicotinique													
Thiamethoxam	100	2	14	30	30	30	18	18	18				
Imidacloprid	72.8	1	n.a.	86	86	86	73	73	73				

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

** The residues obtained don't permit to define the GAP which respect the MRL, thus it is preferable not to use this active substance when taro is grown for leaves consumption

*** The tested dosage is adapted for whiteflies control, for aphid control 100 g/ha dosage is enough.

/ Elements of the recommended GAP not available.

n.a. Not applicable

Defoliating caterpillars
Armyworm - *Spodoptera litura*
Taro hawkmoth/hornworm - *Hippotion celerio*

Strategy: In case of heavy infestation not controlled with biological means or manual pick up an insecticide could be sprayed on foliage.

Active substance	Recommended GAP*									Proposed application period			
				Pre-harvest interval (days) for corms production			Pre-harvest interval (days) for leaves production						
	Dosage	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ	Soil preparation	Cuttings	Foliar development	Harvest and storage
Group 3 – Pyrethroids													
Cypermethrin	70	2	15	15	15	15	**	**	**				
Deltamethrin	12.5	2	15	15	15	15	8	8	8				
Esfenvalerate	12.5	2	/	/	/	/	/	/	/				
Group 1 – Organophosphates and carbamates													
Dimethoate	300	2	/	/	/	/	/	/	/				
Group 18 – Ecdysone aganists/moulting disruptors													
Azadirachtin	150	/	/	2	2	2	/	/	/				
Indoxacarbe	25-40	2	/	/	/	/	/	/	/				
Group 11 – Microbial disruptors of insect midgut membranes													
Bacillus thuringiensis	/	/	/	2	2	2	2	2	2				

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

** The residues obtained don't permit to define the GAP which respect the MRL, thus it is preferable not to use this active substance when taro is grown for leaves consumption

/ Elements of the recommended GAP not available.

Taro beetle - *Papuana* spp.

Strategy: Spot application of insecticide combined with others control methods (agronomic, prophylactic and biological), since no isolated method can control this pest alone.

Active substance	Recommended GAP*									Proposed application period			
	Dosage g/ha	Maximum number applications	Minimum interval between applications (days)	Pre-harvest interval (days) for corms production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ				
Group 4 – Nicotinic Acetylcholine receptor agonists/antagonists													
Imidacloprid	72,8	1	n.a.	86	86	86	73	73	73				
Group 3 – Pyrethroids													
Bifenthrin	/	2	90	/	/	/	/	/	/	Apply around the plant on the soil at planting		Repeat 3 months after 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).

** The residues obtained don't permit to define the GAP which respect the MRL, thus it is preferable not to use this active substance when taro is grown for leaves consumption

n.a. Not applicable

Taro leaf blight - *Phytophthora colocasiae*

Strategy: Foliar application of a fungicide from appearance of symptoms on at least 5% of plants. Monitor particularly during wet period. Treat every two weeks alternating active substances. Treat tubers post-harvest if infected 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) for corms production			Pre-harvest interval (days) for leaves production			Soil preparation	Cuttings	Foliar development	Harvest and storage
				EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ				
Group 4: PhenylAmide fungicides													
Mefenoxam (metalaxyl-M) + Mancozeb	2,5 kg of commercial product at 4 % mefenoxam and 64 % mancozeb	5	14	30	30	30	18	18	18			From symptoms appearance until complete foliage cover	
Group M: Multisite activity													
Copper	360 g/ha	5	14	30	/	/	18	/	/			From symptoms appearance until complete foliage cover	
Mancozeb	2,000 g/ha	3	14	30	30	30	**	**	**				
Not classified													
Sodium hypochlorite (Chlorine/ Javel) at 14,4 % of active chlorine (or 48 °chl)	0.7 litre/10 litres of water	Post-harvest treatment of corms to stop fungus development during storage	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.				Dip corms during 2 minutes in a 1% chlorine solution before packing in polyethylene bags

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

** The residues obtained don't permit to define the GAP which respect the MRL, thus it is preferable not to use this active substance when taro is grown for leaves consumption

/ Elements of the recommended GAP not available.

n.a. Not applicable

Corm soft rot - *Pythium* spp.

Strategy: In addition to agronomic and biological methods, PPP applications could be done : on soil of plots for multiplication purpose, on cuttings before planting or after harvesting.

Active substance	Recommended GAP*									Proposed application period			
				Pre-harvest interval (days) for corms production			Pre-harvest interval (days) for leaves production						
	Dosage	Maximum number applications	Minimum interval between applications (days)	EU MRL	Codex MRL	LOQ	EU MRL	Codex MRL	LOQ	Soil preparation	Cuttings	Foliar development	Harvest and storage
Group M: Multisite activity													
Captan	100 kg/ha	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Apply on the soil before planting. Only on plots reserved to multiplication purpose. Can be used in irrigated plots (taro) rainfed /flood recession (taro and macabo)	Can be used also to dip the cuttings during 12 hours in a 4 g/litre solution		
Group 33 : Phosphonates													
Fosetyl	4 g/litre	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		To be used to dip the cuttings during 12 hours before planting		A post-harvet treatment is also possible for cuttings**
Not classified													
Sodium hypochlorite (Chlorine/ Javel) at 14,4 % of active chlorine (or 48 °chl)	0.7 litre/ 10 litres of water	Post-harvest treatment of corms to stop fungus development during storage	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.				Dip corms during 2 minutes in a 1% chlorine solution before packing in polyethylene bags

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

** Only for planting material

/ 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 substance	Commercial product tested	Manufacturer	Trials	
			Year	Country
cooper sulfate	Cupritozell 24 SC	Zell Chemie Internacional	2009	Dominican Republic
cypermethrin	Galgothrin 25 EC	Chemotecnica	2009	Dominican Republic
deltaméehrin	Decis 2.5 EC	Bayer CropScience	2009	Dominican Republic
mancozeb	Dithane M 45	Dow AgroSciences	2009	Dominican Republic
metalaxyl-M	Ridomil Gold MZ 68 WP	Syngenta	2009	Dominican Republic
pymetrozine	Plenum 50 WG	Syngenta	2009	Dominican Republic
imidacloprid	Confidor 70 WG	Bayer CropScience	2009	Dominican Republic
thiamethoxam	Actara 25 WG	Syngenta	2009	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.

4. Existing registrations in ACP countries

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

Uganda
No information available.

Ghana
Following actives substances listed in part 4 of this Guide have PPP registered on various crops : cypermethrin, deltamethrin, dimethoate , mancozeb.

Jamaica
No information available.

Dominican Republic
No information available.

5. European regulations and pesticide residues

Status of the active substances in Directive 91/414; European and Codex MRLs in August 2010.
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	EU regulation			Codex MRL	
		EU MRL			
	Status DIR 91/414	Corms MRL for Cassava (Dasheen, eddoe (Japanese taro)	Leaves MRL for Spinach & similar (leaves)	Corms MRL for root and tuber vegetables	Leaves MRL for leafy vegetables
Azadirachtin	Not included*	1	1	/	/
Bacillus thuringiensis	Annex 1	n.a.	n.a.	n.a.	n.a.
Bifenthrin	Withdrawn	0.05**	0.05**	0.05**	0.05**
Captan	Annex 1	0.02**	0.1	/	/
Copper	Annex 1	5	20	/	/
Cypermethrin	Annex 1	0.05**	0.7	0.01**	0.7
Deltamethrin	Annex 1	0.05**	0.5	0.01**	2
Dimethoate	Annex 1	0.02**	0.02**	0.05**	0.05**
Esfenvalerate	Annex 1	0.02**	0.02**	/	/
Fosetyl	Annex 1	2**	75	/	/
Imidacloprid	Annex 1	0.5	0.05**	0.5	0.02**
Indoxacarbe	Annex 1	0.02**	2	0.02**	0.02**
Mancozeb	Annex 1	0.05**	0.05**	0.1**	0.1**
Mefenoxam	Annex 1	0.05**	0.05**	0.05**	0.05**
Pymetrozine	Annex 1	0.02**	0.02**	/	/
Pirimicarbe	Annex 1	0.5	2	0.05	0.01**
Thiamethoxam	Annex 1	0.05**	0.05**	/	/
Sodium Hypochlorite	Notified List 4F	n.a.	n.a.	/	/

* Not included in Annex 1 for the time being and the EU Member States have the possibility to maintain authorisations until 31 December 2012
** LOQ
n.a. Not applicable
/ No MRL specified

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. Directive 91/414/EEC provides a comprehensive list (Annex I) of active substances that can be incorporated in plant protection products. This Directive and its amendments are available on: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0414:EN:NOT
The status of active substances can be checked on the following web site: http://ec.europa.eu/sanco_pesticides/public/index.cfm.
Regulation (EC) No 1107/2009 concerning the placing on the market of plant protection products replaces Directive 91/414/EEC from June 14, 2011. http://europa.eu/legislation_summaries/food_safety/plant_health_checks/sa0016_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.htmand 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.

6. References and useful documents

TaroPest is a website for information on the pests and diseases of taro (*Colocasia esculenta*) in the South Pacific.
http://taropest.sci.qut.edu.au/

Marigolds as cover crops. K. E. Dover, R. McSorley, K. -H. Wang, Department of Entomol-ogy & Nematology, University of Florida. 2003.
http://agroecology.ifas.ufl.edu/Marigoldsbackground.htm

Jackson, G. V. H. Secretariat of the Pacific Community, Taro leaf blight. Pest Advisory Lea-flet No. 3, 1999. 2pp. ISBN 982-203-682-5.

De Bon H., Boula R.. 1992. Amélioration de la culture du chou caraïbe, *Xanthosoma sagitti-folium* (L.) Schott, à la Martinique (Improved cultivation of tannia, *Xanthosoma sagittifolium* (L.) Schott, in Martinique. Agronomie tropicale, 46 (1): 3-11.

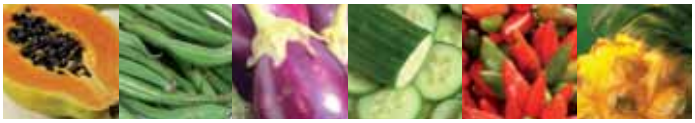
Varin D., Vernier P., 1994. La culture du taro d'eau (*Colocasia : C. esculenta* var. *esculenta*) Agriculture et Développement, n° 4, p. 34-45.

CROP PRODUCTION PROTOCOL

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*)

GUIDE TO GOOD PLANT PROTECTION PRACTICES

Amaranth (*Amaranthus* spp.)
Baby carrot (*Daucus carota*)
Baby and sweet corn (*Zea mayis*)
Baby Leek (*Allium porrum*)
Baby pack choi (*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 tubers and leaves (*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.)
Litchi (*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 tubers and leaves (*Ipomea batatas*)
Table grape *(Vitis vinifera)*
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)



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