PIP

GUIDE TO GOOD CROP PROTECTION PRACTICES

FOR PINEAPPLE (*ANANAS COMOSUS*) IN ORGANIC FARMING IN ACP COUNTRIES

COLEACP is an international network promoting sustainable horticultural trade.

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

www.coleacp.org/pip

PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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Notice

The Guide to Good Crop Protection Practices (organic fruit or vegetable) details all plant protection practices and recommends primarily the active substances supported by Plant Protection Products (PPP) manufacturers in the framework of EU Directive 91/414, allowed for usage by the EU Council Regulation (EC) No 834/2007 on organic production and 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 MRLs and their efficacy. 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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DISCLAIMER

Ongoing regulatory reviews and the implementation of stricter standards have led to many changes to authorisations of plant protection products (PPPs) and maximum residue limits (MRLs), both within the European Union (EU) and at international level. This has a direct impact on producers, who often must change their production practices (good agricultural practices, GAP) to comply with the new rules. Any non-compliances can lead to the interception and destruction of produce, causing significant financial losses as well as reputational damage.

Please note that this document has not been updated since 2011, and information it contains regarding the status of PPP authorisations and MRLs may not be up-to-date. This document is currently under revision.

Before applying any PPP, it is advisable to consult the latest regulatory changes. Producers may supply diverse markets that follow different regulations. EU approval of active substances and MRLs can be consulted in the **EU Pesticides database**[1]. For domestic and regional markets, a list of PPPs registered for use is usually provided by the national competent authorities. African, Caribbean and Pacific (ACP) countries generally apply the MRLs set by the **Codex Alimentarius**[2].

Keeping track of PPP authorisations and MRL changes is complex and time-consuming, but is essential to ensure regulatory compliance. COLEACP has responded to requests to provide a PPP information service that keeps members up-to-date with the changes that are most critical for the ACP fruit and vegetable sector. This includes a database (**e-GAP**) for COLEACP members and partners, which lists EU and Codex Alimentarius MRLs for key horticultural crops in ACP countries. It also provides the GAP (dose rate, intervals between treatments, pre-harvest intervals) that ensure compliance with these MRLs. Additional information is also offered – type of pesticide, registration status of active substance in the EU and in ACP countries, classification recommended by the World Health Organization, and resistance group (FRAC code for fungicides; IRAC classification for insecticides. The e-GAP database can be accessed via COLEACP's e-services website: eservices.coleacp.org.

1 https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN

2 http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticides/en/

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1. Main pests and diseases and importance

1.1. Extent and impact on the quantity and quality of fruit produced

The main pests and diseases that will be discussed in this guide are listed below. This section presents, for each pest or disease:

- the level of economic importance generally observed in ACP countries rated on the following scale: + = low, ++ = average, +++ = high;
- the parts of the plant affected and how they are attacked;
- the resulting types of loss, all of which decrease the yield of marketable fruit and consequently end up causing a loss of financial income. The presence of pests and diseases can reduce yield and cause losses at different levels: fewer plants per hectare, smaller-sized fruits, lower quality of fruits.

MYRIAPODS								
Extend	Organs attacked			Types of loss				
	Leaves	Fruits	Roots	Number of plants	Size of fruit	Quality of fruit at maturity	Post-harvest quality of fruit	Slips and ratoons production
Symphilids - *Hanseniella* spp.								
++(+)			Feed on young roots		Reduced by low development of the plants.			

INSECTS								
Extend	Organs attacked			Types of loss				
	Leaves	Fruits	Roots	Number of plants	Size of fruit	Quality of fruit at maturity	Post-harvest quality of fruit	Slips and ratoons production
Mealybug - *Dysmicoccus brevipes* They transmit the mealybug wilt disease (see below)								
+++	Usually inhabit the axils of the leaves, the basis of suckers, the aerial roots, and the basis of the fruits				Reduced by feeding on the pineapple plant sap			

NEMATODES								
Extend	Organs attacked			Types of loss				
	Leaves	Fruits	Roots	Number of plants	Size of fruit	Quality of fruit at maturity	Post-harvest quality of fruit	Slips and ratoons production
Rotylenchulus reniformis, Pratylenchus brachyurus, Meloidogyne javanica & incognita								
++(+)			Primary roots are invaded weakened and destroyed		Affected when whole plant weakens and wilts.			An infestation can lead to slip production failure.

FUNGI								
Extend	Organs attacked			Types of loss				
	Leaves	Fruits	Roots	Number of plants	Size of fruit	Quality of fruit at maturity	Post-harvest quality of fruit	Slips and ratoons production
Heart rot - *Phytophthora nicotianae* var. *parasitica*								
+++	Enter through the heart of the plant			Plants contaminated die				
Black rot - *Ceratocystis (thielaviopsis) paradoxa*								
+++	Can also affect in smaller way the leaves and the slips	Enters through the peduncle and injuries in the skin of the pineapple					The fruits infected are liquefied and not suitable for export	
Black spot - *Penicillium funiculosum* and *Fusarium moniliforme*								
++		The infection starts from one fruitlet (floral cavity) of the fruits					Infected fruits are not suitable for exports as black spots develop in the fruits	

OTHER DISEASES								
Extend	Organs attacked			Types of loss				
	Leaves	Fruits	Roots	Number of plants	Size of fruit	Quality of fruit at maturity	Post-harvest quality of fruit	Slips and ratoons production
Mealybug Wilt (MWP) Pineapple mealybug wilt-associated virus is a complex of PMWaV-1 and PMWaV-2. The virus is transmitted by mealybug. It appeart that PMWaV-2 must be present for the development of the disease Mealybug Wilt of Pineapple (MWP).								
+++	Develop in the whole plant after transmission by the mealybugs				Fruits may fail to develop or remain small, fibrous and sour			Reduced and not suitable for planting

1.2. Identification and damage

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

NEMATODES

Nematodes – *Rotylenchulus reniformis, Pratylenchus brachyurus, Meloidogyne javanica & incognita*

These nematodes invade the tips of primary roots and stop them from elongating. The formation of root knots or galls is typical of *Meloidogyne* nematodes. *Pratylenchus* and *Rotylenchulus* create root lesions. They can stop root growth by burrowing through the cortex. The last one discolours the roots.

Plant roots infected with nematodes often become more susceptible to other diseases. In addition, affected plants are often stunted.

The pineapple plants infested with nematodes present the same symptoms as when suffering from nutrients deficiency and drought.

Roots of a plant after the attack of nematodes

In the case of *Pratylenchus brachyurus*, there are less or no root hairs, and lesions as well as necroses appear of the leaf sheath, which can easily be separated from the stele, as shown (under the thumb) on the picture above

Formation of root knots (galls) due to *Meloidogyne* presence

MYRIAPODS

Symphilids – *Hanseniella* spp.

Symphilids are small centipedes that feed on roots. Plants suffer from nutrition deficiency, their development is reduced. As symphilids are not present uniformly in the soil, it creates "pockets" of plants attacked by symphilids in the middle of healthy plants.

When an attack ends, many small roots develop from the old ones creating the typical "witches broom".

Symphilids can be observed when uprooting a plant. They are small white worms that tend to escape from the light quickly.

Adult *Hanseniella ivorensis*

Reduced root system

Decay of roots due to symphyles

Gravelly soil is favourable to symphyles

INSECTS

Mealybug - *Dysmicoccus brevipes*

Mealybugs usually inhabit the axils of the leaves, the basis of suckers, the aerial roots, and the basis of the fruits.

They transmit diseases and are associated with the devastating disease, Pineapple Mealybug Wilt. Mealybugs are feeding on the pineapple plant sap which has impact on the size of the pineapple fruit and produces chlorotic areas.

As mealybugs are not mobile, they are found in association with 5 species of ants (among them: the big headed ant and pharaoh ant). The ants transport larvae of the mealybugs and they feed on the sweet honeydew produced by the mealybugs and protect them from their natural enemies like small wasps and ladybugs.

Colonies of *Dysmicoccus* spp. located at the fruit basis

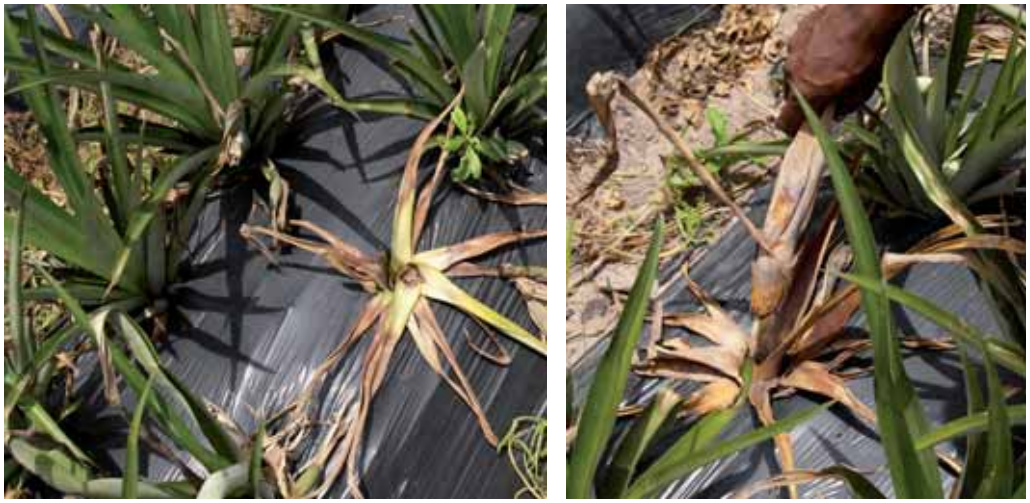
Colonies of ants (as a factor for spreading of the mealy bugs in pineapples)

FUNGI

Heart rot - *Phytophthora nicotianae* var. *parasitica*

The first symptom is that the inner leaves turn yellow and brown. From the base of the leaves the stem will be infected. A brown zone is clearly observed separating the white and green parts of the leaf. At a later stage, leaves can easily be removed from the plant. It produces a strong smell of decomposition.

Later leaves curl and dry from the tip to the base of the plant. An infected plant can be easily removed from the field because of the rotted root system. The contamination occurs at least a month before the first symptoms appear. Young plants are more sensitive than older plants



Pineapple plant affected by heart rot

FUNGI (continued)

Black or soft rot (*Thielaviopsis*) – *Ceratocystis paradoxa*

Infection is visible 2 to 3 days after after infection of the fruit. *Thielaviopsis* is mainly a threat for the fruits but can also affect in smaller way the leaves and the slips. The infected fruits have lateral and peduncle rots. Infected areas are watery and soft.

Black spot – *Penicilium funiculosum* and *Fusarium moniliforme*

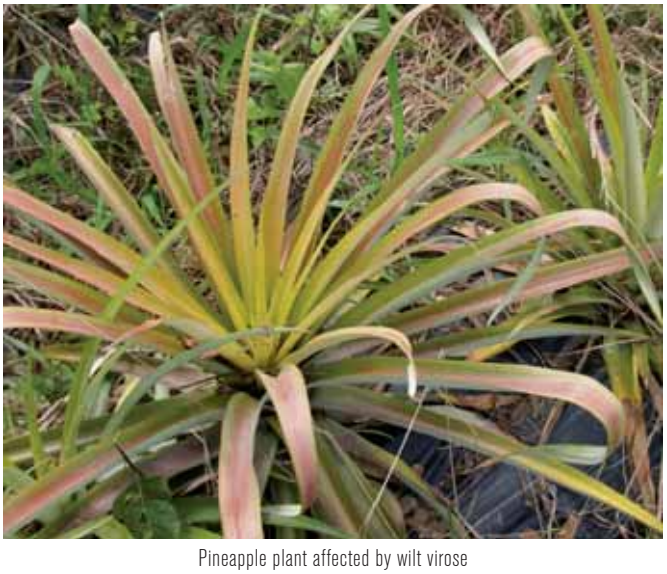
The infection starts from one fruitlet (floral cavity) of the fruits creating a black spot. This browning can expand up to the fruit core. This internal browning can not be seen as long as the fruit is not cut in cylinders. Those symptoms appear 5-6 days after the harvest.

OTHER DISEASES

Mealybug wilt

Wilt is a virus partly transmitted by mealybugs. It affects the root system causing leaves to turn deep pink, yellowing and wilting. Tips die back and edges curl downward. Fruits may fail to develop or remain small, fibrous and sour.

Infected plants present the same symptoms as plants suffering from water stress. Plants infected with mealybug Wilt are isolated. Such symptoms are irreversible and infected plants should be removed as soon as detected.



Pineapple plant affected by wilt virose

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	Nematodes	Symphilids	Mealybug	Wilt	Phytophtora	Thielaviopsis	Fusarium Penicilium
Planting material								
Vegetative stages (from planting to flowering)	8-10 months							
Fruiting stage (from flowering to end of harvesting)	6 months							Near harvest
Harvested fruits								
Slips production	10 months							

Periods during which pest or pathogenic agent is potentially present

Periods during which the appearance of a large numbers of pest or pathogenic agent can cause the greatest loss

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

Key:
GHA = Ghana, TOG = Togo, UGA = Uganda, CAM = Cameroon, RCI = Côte d'Ivoire
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.

Nematodes

Favourable conditions : Very susceptible to drought and excess water. The optimal temperature of development for *Rotylenchulus* is between 29 and 30°C.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
TOG	X	X	X	X	X	X	X	X	X	X	X	X
UGA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
CAM	X	X	X	X	X	X	X	X	X	X	X	X
RCI	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

Symphilids

Favourable conditions : They do not like excess rain/humidity and drought.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	0	0	+	+	0	0	+	+	+	+	+	0
TOG	0	0	+	+	0	0	+	+	+	+	+	0
UGA	X	X	X	X	X	X	X	X	X	X	X	X
CAM	X	X	X	X	X	X	X	X	X	X	X	X
RCI	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

Mealybug Wilt Disease

Favourable conditions : Generally more prevalent in the dry & hot season. But is found throughout the year.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	+++	+++	+++	++	+	+	++	++	++	++	+++	+++
TOG	+++	+++	+++	+++	++	+	++	++	++	+	++	+++
UGA	++	++	+	+	+	++	++	+	+	+	+	++
CAM	+++	+++	++	+	+	++	+++	+++	++	++	+	++
RCI	/	/	/	/	/	/	/	/	/	/	/	/

Phytophtora heart rot

Favourable conditions : Heavy rains, high relative humidity, temperatures between 20-30 °C.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	+	+	++	+++	+++	+++	++	+	++	++	+	+
TOG	+	+	++	+++	+++	+++	+	+	++	++	+	+
UGA	+	++	+++	+++	+++	++	+	++	+++	+++	++	++
CAM	+	+	++	+++	+++	+++	+	+	+++	+++	++	++
RCI	+	+	++	+++	+++	+++	++	+	++	++	+	+

Ceratocystis (thielaviopsis) paradoxa

Favourable conditions : Development during humid and hot periods.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	+	+	++	+++	++	++	+	+	++	++	+	+
TOG	+	+	++	++	+++	++	+	+	++	+++	+	+
UGA	X	X	X	X	X	X	X	X	X	X	X	X
CAM	X	X	X	X	X	X	X	X	X	X	X	X
RCI	+	+	++	+++	+++	+++	++	+	++	++	+	+

Black spot – *Penicilium funiculosum* and *Fusarium moniliforme*

Favourable conditions : High humidity level and rains during flowering stage, or after long drought, or hot periods.

Month	1	2	3	4	5	6	7	8	9	10	11	12
GHA	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
TOG	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
UGA	X	X	X	X	X	X	X	X	X	X	X	X
CAM	X	X	X	X	X	X	X	X	X	X	X	X
RCI	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

2. Main control methods

2.1. Introduction

Successful organic production requires an integrated approach to managing pests and diseases. An important part of this approach involves a number of underlying preventative strategies that can contribute to minimising the likelihood and severity of problems. When these measures are ensured adequately, insect pest and disease infestation will hardly reach economic threshold.

A range of preventative measures is important to minimise susceptibility to pest and disease pressures. Some key preventative measures are as follows:

- **Location/regional occurrence** – Understanding the prevalence, timing and severity of specific pests or diseases for a given location is very important and can have a significant impact on production costs and reliability of production. An organic management plan can be developed to minimise identified risks.
- **Surrounding land use** – Neglected fields or poorly managed surrounding properties can be a constant source for new outbreaks of pest or disease
- **Variety** – Selection of plant material with resistance characteristics should be used wherever possible. Selecting varieties that are well suited to the local growing conditions will ensure healthy growth and resilience to problems.
- **Healthy plants** – Emphasis on maintaining healthy plants that are naturally able to cope with minor pest or disease problems is important. The foundation for healthy plants stems from healthy soil. This is achieved via biologically active soil with adequate organic matter and nutrient cycling to balance the chemical, biological and physical condition of the soil.
- **Biodiversity** – Windbreaks and shelterbelts can be designed to encourage biodiversity and maintain beneficial predators.
- **Hygiene** – Vigilant an thorough hygiene is very important. Removal of infected plants, and plant debris can reduce the severity of subsequent problems.
- **Rapid decomposition** – Infected plant material – as a source of future inoculant – can be reduced by rapid decomposition.
- **Rotation –** Rotate with crops non-host of pineapple pests and diseases
- **Fallow period of at least 6 months without any crop residue.**
- **Usage of clean planting material**

Proper identification, regular monitoring and timely intervention are essential for successful pest and diseases management.

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.

For more information on crop practices one should consult Technical Itineraries 'Cayenne and MD2' edited by PIP on conventional production of pineapple.

NEMATODES

Eggs of *Meloidogyne* and *Rotylenchulus* nematodes are laid in a gelatinous matrix, 40-60 eggs per mass. Eggs hatch in 8-10 days, and then juveniles undergo 3 molts in the soil without feeding. Young females are the infective stage and only females are parasitic. Females enter root with posterior outside, feed and swell to reniform shape. Males do not feed. The life cycle is completed in 25 days at 25°C. *Pratylenchus* nematodes reproduce by parthenogenesis. Males are very rare.

Natural factors favourable to the pest

- Low organic matter content
- Sandy soils for *Meloidogyne* and *Rotylenchulus*
- Low level of populations of antagonistic micro-organisms. Excessive cultivation, for example, hastens the break down of organic matter and with it micro organisms.
- Low PH, under 4, especially for *Pratylenchus*.

Major elements of the control strategy:

Their aim is to slow down the nematodes' population dynamics. It is then crucial to start from a situation where nematodes are not present in the planted fields. It is a management disease so proper organic management practices have to be developed to minimise nematode attack.

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

Stages of development of nematodes	Control methods	Crop stages					
		Pre-planting	Planting material	Vegetative stages (from planting to flowering)	Fruiting stage (from flowering to end of harvesting)	Slips production	Fallow
Transportation by water or by soil or by infected planting material	Soil coming from infested fields should not be imported.	X	X				
	Planting materials should be free from nematodes. Basal leaves should be pealed to accelerate the root growing stage.	X	X				
Conservation in the soil	Turning the field over and planting a green manure* or different types of grass for three years may suppress nematode infestations and improve the soil. This is only practical if sufficient arable land is available.	X					X
Mobile phase in the soil	Application of sawdust and chicken manure improves crop nutrition and has a side benefit of controlling root knot nematodes. Improve soil fertility by application of compost or other organic manure. Decaying organic matter activates soil fungi that catch nematodes.	X		X	X	X	
	Flooding and solarization for a long period can reduce infestation by killing larvae and adults.	X					
Penetration and development in the plant	To avoid root penetration and development, a spot treatment (beds, planting beds) can be done with allowed PPP.	X		X			
Multiplication on other host plants	Proper rotation with non susceptible plants*. Plant in soils where in the previous year no vegetables or ornamentals have been growing. Nematodes will die of starvation when fields are kept free of host plants, including some weeds. This can be achieved by a fallow period of 4-12 months or by crop rotation with a non-host plant.	X					X

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

* See on the following page a list of recommended green manures and non-host plants

Non-hosts and hosts plant of nematodes

	Non host plants that can be used as cover crops	Host plants
Meloidogyne	- Velvet bean *(Mucuna pruriens)* - Forage peanut *(Arachis pintoi)*. - *Cruciferae* (plants of this family suppress nematodes). When residues of cruciferous plants decompose in the soil they have a 'bio fumigation' effect.	- Eggplants - Tomatoes - Sorghum (-) - Maize (-)
Rotvlenculus reniformis	-Velvet bean (*Mucuna pruriens*) - *Crotalaria juncea* (Sunhemp), - *Triticum aestivum*, - *Sinapis alba* (yellow mustard), - *Tagetes erecta* (Marigold), - *Glycine javanica*.	- Fruit trees (ie. papaya, citrus, mango) - Soybean - Cowpea - Cabbage - Cassava - Eggplants - Tomatoes
Pratylenchus brachyurus	▪ Pois mascate (*Mucuna pruriens*) ▪ *Digitaria umfolozi*	- Maize - Cassava - Rice - Cereals - Coffee

SYMPHILIDS

Females deposit clusters of eggs into the soil. Hatching is complete in 10 days. Adults may live for 4 or more years.

Natural factors favourable to the pest

- Clayey soils
- Soils rich in organic matter
- Small rains
- Medium humidity level
- Period of roots development

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

There are only a few crop practices and organic products available for organic growers to fight against symphylids.. It is important to know that when the moisture is sufficient, symphilids can survive for 4 months without any source of food. When planting in a land whit an history of symphilids, try to have the root flushes during the dry season.

Choice of the piece of land

- It is highly recommended to plant pineapples in an area free from symphilids
- Avoid clayey soils

Pre-planting

- Application of compost and manure very well degraded as a soil too rich in organic matter is a very favourable environment for symphilids

After the final harvest

- Proper rotation with non-host plants like cereals for instance.
- During fallow, pineapple plants should be completely destroyed.

At root flushes

- Spot treatments are recommended in the “pockets” of infestation.

MEALYBUGS & WILT DISEASE

All stage of development take place on the pineapple plant. A field can be infested directly by the mealybugs or by the use of infested planting material.

It is not necessary to take into consideration the stage of development of the mealybug to control it. Its sole presence (disregarding of the stage) can bring Wilt disease. As mealybugs are not mobile, they are found in association with 5 species of ants (among them: the big headed ant and pharaoh ant). The ants transport larvae of the mealybugs and they feed on the sweet honeydew produced by the mealybugs and protect them from their natural enemies like small wasps and ladybugs. The presence of the ants is very important to the mealybugs' survival. Populations of mealybugs only increase when ants are attending them. Elimination of the ants will usually mean the destruction of the mealybug colonies.

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

Control methods	Crop stages					
	Pre-planting	Planting material	Vegetative stages (from planting to flowering)	Fruiting stage (from flowering to end of harvesting)	Slips production	Post harvest
To reduce mealybugs population						
Physical barriers such as ant fences running parallel to the field periphery are partially successful in keeping ants out of the field, and subsequently controlling mealybug populations.			X	X	X	
Pealing of the basal leaves on slips	X					
At planting, healthy seedlings should be selected and can be treated in hot water. Heat treatment reduces the colonization of mealybugs		X				
Borders of fields and fields itself should be kept clean of weeds as mealybugs are hosted by several weeds. Weeds also maintain ant populations by providing alternative food for ants.			X	X	X	
Proper rotation with plants that are not hosts of mealybugs and ants. All crop residues should be removed and burned. Crop residues and grass roots left in the field may harbour mealybug populations and will infest the new crop.	X					
The mealybugs present at the basis of the fruits can be removed by a gentle brushing.						X
High importance of starting with clean planting material with suckers dipping and to keep wilt from spreading to adjacent plants with spot treatments to kill mealybugs and ants that are vectors of the mealybugs.		X	X	X	X	
To reduce wilt disease inoculum						
Infected plants as well as the immediate surrounding ones should be uprooted and removed from the field (burned or buried) . The plants located around the infested one may not develop the symptoms but they are potential vectors.			X	X	X	
Careful selection of the slips is recommended. Slips or suckers from an infected mother plant should never be used.		X			X	
Fields infested with wilt should be turned over.	X					

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

PHYTOPHTORA

The fungus *Phytophtora nicotiana* is present in the soil. Its spores are transported by surface water.

Natural factors favourable to the pest

- pH above 6
- MD2 variety is more sensitive to *Phytophtora* than Smooth Cayenne and the other traditional varieties
- Presence of stagnant water

Stages of development of *Phytophtora*	Control methods	Crop stages					
		Pre-planting	Planting material	Vegetative stages (from planting to flowering)	Fruiting stage (from flowering to end of harvesting)	Slips production	Fallow
Conservation in the soil	Especially when growing MD2 variety, alkaline soils should be avoided.	X					
	Soils should be light, well aerated and drained. The field lay-out should be designed in such a way that there is no stagnant water in the field. Pineapples can be grown on raised beds or ridges.	X					
	Improve quality of the soil by applying organic manure.	X		X	X		
Transportation by water, by soil or by infected planting material	Planting materials should not be kept too long as fresh planting material is less sensitive to Phytophtora. It should not be stored in heap.	X					
	Be sure that planting materials is taken from healthy plants.		X				
	Movement of infected material into the farm should be avoided.		X				
	As soon as an infected plant is detected, it should be uprooted and burnt. Those plants should not be kept in or around the field as it is a source of contamination.			X	X	X	
Penetration and development in the plant	When producing MD2, gauging should be done carefully as it can facilitate infection by *Phytophtora*.				X		
	Dipping the suckers and/or spot treatment around the uprooted plants.		X	X	X		
Multiplication on host plants	Proper rotation with non susceptible plants. A proper rotation will also improve soil quality. Host include tobacco, cashew, jackfruit, papaya, capsicum, sweet potato, tomato, cassava, guava, sesame, eggplant and many others. For instance rotation can be done with corn, soybeans, peanuts, sugarcane.	X					X

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

CERATOCYSTIS (THIELAVIOPSIS) PARADOXA

It is important to know that this fungus enters through the section of the peduncle and through injuries of the pineapple skin. The fungus is an injury pest that cannot penetrate the intact skin of a fruit but enters the slightest bruise or the cut. It causes lateral and peduncle rots. The symptoms appear 3-4 days after infection.

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

Control methods	Crop stages					
	Pre-planting	Planting material	Vegetative stages (from planting to flowering)	Fruiting stage (from flowering to end of harvesting)	Slips production	Post harvest
Exposure of the butt end to the sun can cure the planting material. Do not store planting material in heap for too long.		X				
General sanitation measures should be taken in and around the fields as spores are spread by the wind. Those spores are present on the crop residues, debris.	X		X	X		X
All the operations from the harvest up to the packing of the fruits should try to minimize the fruits chocks. The fruits should be handled carefully. During storage or transport, they should never be in heap. Movements and chocks should be reduced. It is recommended to use crates. Bruising could be avoided with the use of long foam/diapers between fruits. Padded cages could also be developed for field transport on trailers.						X
There should be a strict hygiene in the packing station (floor, tables…) and around it. Everything in contact with pineapples should be disinfected regularly (harvesting tools, crates…).						X
Fungicides should be applied to protect the entrance gates of *Thielaviopsis* (peduncles & skin wounds of the fruit). The objective is to reduce the PH.						X

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

BLACK SPOT

The cycle of this fungus is not well known. The fungi penetrate at a very early stage when the inflorescence is still in the heart of the rosette of flowers before emergence.

Variations in the intensity of black spot cannot be predicted and may be very sudden

Post-harvest handling

As the spots develop rapidly when they approach maturity, the problem is mainly limited by picking earlier. However, this should .not jeopardize the test quality of the fruits by picking too early immature fruits. Time between flower induction and harvesting should be adjusted carefully by regular observation of the fruits.

It is also recommended to minimise fruit chocks throughout the whole production chain.

2.3. Cultivar resistance or tolerance

Not any cultivar resistance. MD2 is more sensitive to *Phytophtora* than the other varieties grown (Smooth Cayenne, Sugar Loaf, and Queen Victoria).

2.4. Use of natural enemies

In organic agriculture, one of the most important goal is the achievement of healthy plants by encouraging an ecological balance between pests and beneficial species.

Some natural enemies are present in the environment. Natural enemies mostly live outside the field as there is little habitat for them in the pineapple field. The width of the fields should allow natural enemies to move into the field and do their work. This is not expected to be a problem in smallholder pineapple growing, but it is a problem in the large monoculture fields of commercial farms. In organic pineapple farming, hedges are often necessary as buffers but they also provide the habitat for natural enemies.

2.4.1. MEALYBUGS

Although many natural enemies to the pineapple mealybug are present, they exhibit minimal control if protective ants are tending the mealybug colony.
The main natural enemy is the coccinelid beetle. Farmers can increase their population by creating a better habitat for them.

- Description of ladybird beetle:
  Eggs are yellow to orange in colour, and are laid in circular clusters of 10 -50 eggs on the underside of leaves. Newly hatched larvae are grey or black and less than 4 mm long.
  Adults are oval to hemispherical and strongly convex with short legs and antennae. Most species are brightly coloured. Body length ranges from 0.8-16 mm. Their colours tell other predators that they are tasteless and toxic. When disturbed, some of them emit a strong smelling yellow liquid as a protection against other predators. Their colours vary from red, orange, steel blue, yellow-brown, or yellow elytra, frequently spotted or striped with black.
  They feed on pollen, nectar, water, and honeydew but aphids or other prey are necessary for egg production.

- Conservation
  Lady bird beetles are found in most agricultural and garden habitats. These beetles are attracted by the flowers of the *Cruciferae* and *Compositae* family. Planting these flowers around the fields or even within the fields will attract the beetle. Their presence indicates that natural biological control is occurring. It is important to maintain habitats planted with several flowering crops. These give the ladybird beetles varied food sources. When food is not available, they tend to eat each other. Their beneficial predatory behaviour and activities are continuous when there is no indiscriminate use of synthetic pesticides.

2.4.2. NEMATODES

Rove beetles are natural enemies of nematodes.

- Description:
  Both adults and larvae are predators of root maggots' eggs and larvae, mites, worms, nematodes, and other small insects. Adults tend to be cannibalistic, eating their own eggs and attacking other adults when food supply is low.
  Females lay the eggs in the soil among the roots of infested plants. Before pupating, a larva will actively search for a host (pupa of maggot) in the surrounding soil. It will pupate in the pupa of the maggot by entering into its cocoon and feeding its contents, and then pupate itself inside for about 3-4 weeks before emerging as an adult.
  Adult rove beetles are brown, reddish-brown, or black or have grey markings on the wings and abdomen, with slender elongate bodies. Their wing covers are shorter than the abdomen where most part of the abdomen is exposed. Both adults and larvae have well-developed 'jaws' cross in front of the head. They live mostly in decaying organic matter but are also found in moist

agricultural soils or in habitats where large numbers of fly larvae live. When disturbed, they run very fast, with their abdomen lifted upward, like that of scorpions. Adults are good fliers as well.

- Conservation
  Provide ground covers or mulches within and around fields for rove beetles love to stay in moist decaying organic matter; provide hiding sites and alternative habitats and plant flowering borders, hedges, and other perennial habitats as a source of food and shelter; and provide protection by not spraying broad spectrum pesticides.

3. Crop monitoring and intervention thresholds

Essential measures to prevent diseases are general crop practices.
When a pest has been identified, it is recommended to look first at the corresponding control measures on how to lessen its population density. There are various options like: cultural practices (e.g. removal of weeds); physical control (e.g. handpicking), use of baits, before using plant protection products like plant extract (e.g. neem spray) or other homemade solution (e.g. soap spray). Most of the plant protection products are non selective and have a negative impact on beneficial species as well.
That is why it is important to monitor regularly the pest and diseases in the field in order to prevent any outbreak that would oblige to spray the entire field.

Example of monitoring guideline for pineapple:

Pest or disease monitored	When ?	Frequency	Where?	How?	Sampling
Nematodes	Vegetative stage mainly	Minimum every 2 months	- General aspect of the fields - Roots	- Uprooting - Soil & roots analyses	10 sites/ha, 2 plants/ site.
Symphilids	Vegetative stage	Minimum every 2 months	- General aspect of the fields - Roots	Uprooting	10 sites/ha, 2 plants/ site
Mealybug wilt	Vegetative & fruiting stages	1,5 months 3,5 months 6, 8 & 10 months	Basis of the leaves	Pulling the last leaf	10 sites/ha, 2 plants/site
Phytophtora	Vegetative & fruiting stages	10 sites/ha, 2 plants/ site	Basis of the leaves	Pulling the medium-aged leaves	10 sites/ha, 10 consecutives plants
Ceratocystis			Fruits		
Black spot		Feedback at arrival	Fruits	Cutting fruits in cylinders	

The frequency of monitoring should be increased when there are favourable conditions for the development of the pest.
The operator in charge of monitoring on disease or pest should be the same one for each monitoring visit. A monitoring form should be filled in.
Pest population dynamics need to be monitored. It is very valuable to know and analyse the evolution of the pressure and to decide how to handle the problem.

Nematodes

Soil and roots analyses should be done by laboratories. It will help to know the nematodes situation of the different plots of lands. Depending on the local conditions, and the nematode species, threshold levels can be set.

Mealybugs & wilt

As natural enemies present in the field are very important to keep pest populations under thresholds level, it is recommended to make only spot treatments when a large number of adult scales or crawlers are identified. Indeed organic widespread application would interfere severely with natural enemy activities.

Thresholds level should be determined at the farm level taking into consideration local conditions.

Symphilids

When infestations are suspected, examine the soil and look for small white worms (2-6 mm) that go away from the light when disturbed and escape quickly into the soil. It is said that a mature plants can tolerate up to 50 symphilids, but younger plants in development are much more vulnerable.

***Thielaviopsis*:** Quality check of the fruits at arrival. There should be feedback from the importers to the producer.

4. Active substances and treatment recommendations

We give a list of the plant protection products allowed for usage by the Council Regulation (EC) No 834/2007 on organic agriculture and that can be recommended on pineapple. Prior to any usage, the producer should check with his certification body that such usage is allowed.

A distinction is done between the active ingredients from commercial products and the active ingredients from farm-made products. For each type of product we give the recommended GAP that allow conformity with European Regulation on residues. Proposed period of spraying are highlighted in the tables with green color.

Very often, organic farmers in ACP countries use farm-made botanical extracts for which exact concentration in active ingredients is not known. In most of the cases, the active ingredients of plant extracts are degraded very quickly and leave no residue. The PHI is then set at the minimum (2 days) and residues are hardly a problem even when MRLs are set at LOQ.

Our recommendation of usage for the following natural plant protection products are based on producers' experience, organic resources centres and other literature available, but very often it is difficult to get well documented scientific results of trials specific to pineapple production. Some researches and trials are or have been conducted but the information is seldom shared among stakeholders.

In the case of farm-made products, indications to prepare the farm-made products are given after the tables of products.

Floral induction by ethylene treatment.

This treatment can be carried out by mechanisation (for large scale fields) or by use of a knapsack sprayer or a powder dispenser (for small scale fields).

The mechanisation requires a heavy investment. It also requires a large amount of water. The principle is the injection under pressure of bottled gaseous ethylene into water containing active carbon that is immediately sprayed on the plants (using a boom sprayer). Spraying one hectare requires 6,000 litres of water, 800 g (or approximately 650 l) of ethylene and 3 kg of active carbon. Treatment can be performed during the night or early in the morning. It must be repeated after 3 days. The water used must be as cool as possible for easier dissolving of the ethylene.
The main problem in this treatment is the difficulty of injecting ethylene in water and ensuring that there is no leakage. The entire gas circuit must receive regular maintenance. And the injector very well selected.

A method for small producers to enrich activated carbon with ethylene was developed in 2006.
The enrichment process for activated carbon requires readily available material: an explosion-proof vacuum pump, a bottle of ethylene with a regulator, an adapted airtight container, a gauge and some tubes, valves, fittings and filters. Assembly of the prototype requires standard workshop material.
Two methods of application can be used: a dry treatment with granules of enriched activated carbon, whereby the enriched granules are applied directly into the heart of the plants using a powder dispenser; and a wet application, whereby enriched powder is mixed in the tank of a knapsack sprayer immediately before treatment and the spray is applied directly into the heart of the plants using the sprayer. These techniques are described in details in a technical sheet edited by PIP/COLEACP in 2007.

The EC regulation 1318/2005 allows the usage of ethylene for artificial flower induction. But it is not approved by all the certification bodies. Each producer should check with it own Certification Body).

Nematodes

Strategy: As there are almost not any organic existing nematicides available, organic growers must emphasize the use of cultural practices to control nematodes populations and should start with fields and planting materials free from nematodes (no roots). To avoid root penetration and development, a spot treatment (beds, planting beds) can be done with the following products when the soil is heavily infested.

Commercial products

Active substance	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Azadirachtin	30	/	/	2						
Paecilomyces lilacinus (pathogenic fungi)	1000 (for a concentration of 10e11 viable spores/ g)*	/	/	2						

Plant extracts or "farm-made" concoctions

Product	Recommended GAP				Proposed application period					
	Dose	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Garlic leaves	/	/	/	2	For incorporation in the soil		For incorporation in the soil	For incorporation in the soil		For incorporation in the soil
Garlic, chili, ginger, papaya and mango extracts solutions	/	/	/	2		Dipping	**			
Wood ash solutions	100g/litre of water for dipping Non available for drenching	/	/	2		Dipping	Drenching			

/ : Not available

* Depends of the concentration in spores/ g of commercial product

** Garlic solution can kill nematodes if soil or batches of soil are drenched

Symphilids

Strategy: Practice rotation and fallow as there are only a few products tested for Symphilids in organic agriculture. Spot treatments are recommended in the "pockets" of infestation.

Commercial products

Active substance	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Azadirachtin	30	/	/	2						

Plant extracts or "farm-made" concoctions

Product	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Garlic extract solution	/	/	/	2			Drenching			
Wood ash solutions	100 g/ litre	/	/	2			Drenching			

/ : Not available

Mealybugs (WILT)

Strategy: High importance of starting with clean planting material with suckers dipping and to keep wilt from spreading to adjacent plants with spot treatments to kill mealybugs and ants that are vectors of the mealybugs..

Commercial products

Active substance	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Azadirachtine	30	/	/	2		■	■	■		■
Rotenone	/	/	/	2		■	■	■		■
Beauveria Bassiana	/	/	/	2		■	■	■		■
Fatty acids of potassium salts	8-10 g/l (600-800 l/ha)	/	/	2		■	■	■		■

Plant extracts or "farm-made" concoctions for the control of ants

Product	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Extracts of marigold (*Tagetes* spp.)	/	/	/	2	■		■	■		■
Extracts of *Tephrosia* leaf powder	Usage in baits				■		■	■		
Citrus oil	/	/	/	2	■		■	■		■
Garlic extracts solutions	/	/	/	2	■		■	■		■

- **Fatty acids of potassium salts:** Active ingredient present in soft soap; also called soap insecticide solution: use soft soap used for washing dishes and not washing powders since these can harm plants.. Soap can also be used to control ants.

/ : Not available

Phytophthora

Strategy: Dipping the suckers and/or spot treatment around the uprooted plants.

Commercial products

Active substance	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Azadirachtine	30	/	/	2		■	■	■		■

Plant extracts or “farm-made” concoctions

Product	Recommended GAP				Proposed application period					
	Dose g /ha	Number of applications	Interval between applications in days	PHI in days	Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Wood ash solutions	100 g/l	/	/	2		■				
Papaya leaves & stems extracts	/	/	/	2	■		■	■	■	

/ : Not available

Soils and leaf axils could also be treated preventively with *Trichoderma* if bioassays prove positive efficacy.

Thielaviopsis

Strategy: Fungicides should be applied to protect the entrance gates of thielaviopsis (peduncles & skin wounds of the fruit). The objective is to reduce the pH.

Commercial products

Active substance	Recommended GAP	Proposed application period					
		Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Ascorbic acid 2,5 % + Citric acid 3% + Lactic acid 4%	Dipping 1ml/l of water					Dipping of the peduncle or the whole fruit	

Plant extracts or "farm-made" concoctions

Product	Recommended GAP	Proposed application period					
		Pre-planting	Planting material	Planting to flowering	Flowering to harvest	Post-harvest	Slips production
Chlorine water (bleach)	For disinfection of tools and cleaning of packing house, used as dilute solutions, not typically considered as pesticides.						
Lime juice*	Pure					Disinfection	

* Lime juice: Used pure for disinfection of harvesting tools as well as the one used to re-cut the peduncles. The section of the peduncles can be treated with lime juice

Fusarium, Penicillium

Strategy: This fungus is not known enough to recommend any plant protection product.

Preparation and direction for use of "farm-made" concoctions:

- Usage of neem tree (*Azadirachta indica*, family *Meliaceae*) extracts for spot spraying treatments. The effective ingredients are present in all parts of the tree but are most highly concentrated in the seeds. The insect controlling substances are primarily azadirachtin A and B. In addition, neem contains a number of other substances such as Salannin and Meliantriol, which have primarily repellent effects, and Nimbin/Nimbidin, which seem to have antiviral effects. Some substances support each other, thus creating synergistic effects.
Neem seeds should be dried well so that they do not produce the toxic aflatoxins which impair their pest control properties and which are highly toxic to humans. When harvesting neem seeds, care must be taken that the fruit colour is neither greenish-yellow nor brownish-yellow but plain absolute yellow. Greenish yellow fruits are not fully mature and are low in azadirachtin content. For the collection of the fruits, spread a plastic or cloth under the tree. Thus they do not come in contact with the soil and the danger of fungus attack and aflatoxin development is reduced. After collection, the fruit pulp should be removed. The seeds are then dried for one day in the sun, and the following three days in the shade, during which they are regularly stirred. Stored neem kernels should be kept in well aerated containers or jute bags to prevent mould, which would reduce effectiveness and produces the highly toxin aflatoxin.
Seeds between 3 and 9 months after harvest have the highest quantity of azadirachtin. Germination of neem seeds will decrease about one month after harvest and if exposed to temperatures higher than 45°C.

Characteristics

- For sprays or dipping with neem seeds, only seeds which are green inside have a high azadirachtin content. If they are brown inside, they should be discarded.
- The pulp of the fruits has no insect control properties and should be removed.
- Azadirachtin is highly sensitive to ultraviolet light. Therefore spraying in the evening is highly recommended. Spraying also should be done immediately after the preparation is prepared.
- Degradation in 24 hours, no risk of residues.

Dosage recommendations:

- For seeds: per ha, about 30 g of azadirachtin is required. In neem seeds, contents between 2 and 9 mg/g can be found. (5 to 10 kg of seeds/ha)
- For usage of pounded neem leaves: concentration 100g/L.
- The solution should be left for decantation one day and then sprayed immediately after filtration on targeted pest.

The neem cake which is left after the oil is extracted from the seeds, can control nematodes.

- Rotenone extracted from *Tephrosia vogelii* (*Papilionoideae*)

Tephrosia is widely found in tropical Africa. Leaves of T. *vogelii* contain at least 4 insecticidal compounds collectively known as rotenoids (80-90%). The insecticidal effect is quite high with up to 90% mortality reached. Although the amount of leaves required for the preparation of the insecticidal sprays is quit high, the residues can be used as mulch or green manure. Managing the volumes is the greatest problem for large scale adoption.
Some organic certifiers disapprove the use of rotenone in organic agriculture.
With only few nests in the field it is possible to bait ants with a sugar solution with *Tephrosia* leaf powder to kill the ants. Care should be taken that no other mammals can eat from the bait.
Rotenone is rapidly broken down by sunlight so evening spraying may provide best results
Degradation in 24 to 48 hours, no risk of residues

Control of ants:

Extracts of marigold (*Tagetes* spp.)

- Crush large quantities of fresh flowers (roots and leaves can be added) and put this in water. Leave this for 5 to 7 days while stirring daily. Filter the mixture using a cloth. Dilute the mixture and add liquid soap (use soft soap used for washing dishes and not washing powders since these can harm plants). Preventative this should be applied once a week.

Citrus oil

- Homemade citrus oil can be made by soaking citrus peelings in an equal amount of water for 10 days to two weeks. Adding garlic-pepper tea makes the spray even more powerful. This same spray will also help control aphids, white flies. It will also kill beneficials so don't use unless pests are a problem. Possible phytotoxicity.

5. Existing registrations

The market of ACP organic producers is still very small and young, therefore, organic plant protection products specific to pineapple are seldom developed. Even when an organic pesticide is registered in the producing country, it is for general use, and as such there are not specific recommendations for pineapple crops.

Registration of active ingredients was not required for the "farm concoctions" made out of plants extracts because in all the ACP countries we've received information from, there is no legislation for such products. It is not written that it is allowed to use them, they are just not mentioned and accepted as long as they don't leave residues.

Registration in Ghana

Active substance	Type of registration	Targeted pests and diseases						Registration GAP			
		Nematodes	Symphilids	Mealybug wilt	*Phytophtora*	*Ceratocystis*	Black spot	Dose g /ha	Number of applications	Interval between applications	PHI in days
Azadirachtin	Under consideration for papaya, mango & vegetables	X	X	X	X			/	/	/	/
Ascorbic acid 2,5 % Citric acid 3% Lactic acid 4% (Preserve Pro)	In process for 2007					X		1ml/l	1	NA	NA

/ : Non Available
NA : Non Applicable
One organic pesticide made out of neem extracts is in the process of registration for tomatoes.
In order to be allowed to use a pesticide registered for another crop, there should be an application for extension of usage (from major to minor usage).

Registration in Cameroun

Active substance	Type of registration	Targeted pests and diseases						Registration GAP			
		Nematodes	Symphilids	Mealybug wilt	*Phytophtora*	*Ceratocystis*	Black spot	Dose g /ha	Number of applications	Interval between applications	PHI in days
Azadirachtine	/	X		X	X			/	/	/	/
Ascorbic acid 2,5 % Citric acid 3% Lactic acid 4% (Preserve Pro)	In process Banana & pineapple					X		1ml/l	1	NA	NA
Paecilomyces lilacinus	In process Banana	X						/	/	/	/

/ : Non Available
NA : Non Applicable

Registrations in Uganda

None of the listed plant protection products are registered in Uganda.

Registrations in Togo

None of the listed plant protection products are registered in Togo.

Extra ACP existing registrations

Active substance	Type of registration	Targeted pests and diseases						Registration GAP			
		Nematodes	Symphilids	Mealybug wilt	*Phytophtora*	*Ceratocystis*	Black spot	Dose g /ha	Number of applications	Interval between applications	PHI in days
Azadirachtine	Pineapple USDA-NOP			X				12-45	/	3-10 days	/
Beauveria bassiana	USDA NOP			X				/	3-5	7 days	/
Pyrethrin	Pineapple USDA-NOP		X	X				15-55	/	/	/
Soap (fatty acids potassium salts)	Pineapple USDA-NOP			X For Soft-bodied insects				Solution 1-2 %	/	/	0
Ascorbic acid 2,5 % Citric acid 3% Lactic acid 4% (Citrex)	Pineapple USDA-NOP + Banana					X		1ml/l	1	NA	NA
Paecilomyces lilacinus	Banana Antilles	X						/	/	/	/

USDA/NOP : The production rules for organic production according to the U.S. Standards have been laid down in the National Organic Program (NOP) of the United States Department of Agriculture. This Regulation is in force within the U.S.A., but also sets criteria for importing organic products to the Unites States of America.

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CROP PRODUCTION PROTOCOLS

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

GUIDES TO GOOD PLANT PROTECTION PRACTICES

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

PIP
FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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