THE MINISTRY OF AGRICULTURE AND AGRO-BASED INDUSTRY
KUALA LUMPUR
MALAYSIA

TECHNICAL DOCUMENT

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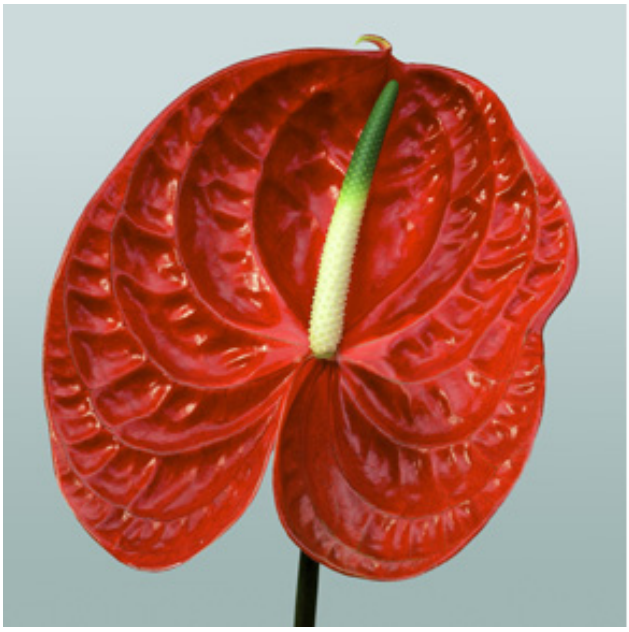

ON ANTHURIUM

CROP PROTECTION & PLANT QUARANTINE SERVICES DIVISION
DEPARTMENT OF AGRICULTURE
KUALA LUMPUR
MALAYSIA
2004

Ms. Asna Booty Othman, Director, Crop Protection and Plant Quarantine Services Division, Department of Agriculture Malaysia, wishes to extend her appreciation and gratitude to the following for their contribution, assistance and cooperation in the preparation of this Technical Document For Anthurium:-

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Ms. Nuraizah Hashim, Agriculture Officer, Phytosanitary and Export Control Section, Crop Protection and Plant Quarantine Services Division, Department of Agriculture Malaysia;

Mr. Tung Khoon Cheong, Assistant Director, Industrial Crop and Horticulture Division, Department of Agriculture Malaysia.

Appreciation is also extended to Y. Bhg. Dato' Ismail Ibrahim, Director-General of Agriculture, for his support and guidance in the preparation of this Document.

CONTENTS

Flamingo lily (*Anthurium andraeanum)*

AGRONOMY ASPECTS

Botanical name: *Anthurium andraeanum*

Classification:

Division : Magnoliophyta
Class : Liliopsida
SubClass: Arecidae
Order: Arales
Family: Araceae
SubFamily: Pothoideae
Tribe: Anthurieae

Common name : Flamingo flower
Flamingo lily

Introduction

Anthurium belongs to the family Araceae. It is native to Central and South America countries such as Ecuador, Colombia, Peru, Brazil and Venezuela. They are mainly perennials and semi epiphytes, some with climbing and creeping habits. Anthurium has been identified as a potential cut flower in Malaysia. In Malaysia anthurium is mostly grown in Pahang (Cameron Highlands), Selangor, Perak and Johor, mainly for cut flower production. Besides for cut flower production, it is also very widely accdepted as potted ornamental for indoor landscaping.

Anthurium andraeanum is mainly grown for the cut flower trade. Red, pink, orange,white, green and bicolors flowers are usually grown. In the early 70's the variety *Anthurium amnicola* (formerly known as A. Lilacinum) was introduced to the horticultural world. Amnicola is a miniature, no more than six to eight inches in height, with leaves that are narrow and dark green. This variety is situable for pot culture.

Popular varieties grown in Cameron Highlands for cut flower productions are Choco, Cheers, Fantasia, Midori, Pistache, Sante, Simba, Sunglow, Terra and Tropical.

BOTANICAL DESCRIPTION

Flowers

The elegant blooms of this tropical aroid are produced and sold throughout the world. The true flowers are found on the “spadix”, the upright organ in the center of the “spathe”, which is the decorative petal-like organ surrounding the spadix. Although anthuriums are sensitive to low temperatures, they have a long vase life when properly handled. The end of their vase life is usually the result of inability to draw water from the vase solution, and is associated with loss of glossiness and then blueing of spathe. Most of the water lost by the flower evaporates from the spadix. Application of wax, to prevent this water loss, or pulsing with silver nitrate, to improve water relations of the flower, can extend their vase life considerably.

Leaves

Leaves are large, carried on long petioles and have a heart – shaped appearance and of various colors. They have a prominent mid-vein and lateral veins.

RECOMMENDED CULTIVAR

Species

Only three main species are grown as ornamental plants in Malaysia.

Anthurium andraeanum

A flowering plant up to 30 cm tall with red, pink, orange, bicolor or white spathe 8 to 9 cm width, spadix 5 to 6 cm long. Leaves are heart-shape and glossy dark green.

Anthurium scherzerianum

Plant height 20 to 23 cm with narrow dark-green leaves, glossy dark red spathe and with curling spadix.

Anthurium crystallinum

This anthurium does not have showy flower but are grown for its velvety, dark green heart shape leaves. Leave veins are silvery white in colors.

Some popular varieties for cut flower production are:

Variety	Spathe Color	Spadix Color
1. Tropical	Dark red	Yellow with green tip
2. Sanate	Light pink	Yellow with green tip
3. Fantasia	Whitish pink	Pink
4. Choco	Dark reddish brown	Cream with yellow tip
5. Midori	Light green	Cream with yellow tip
6. Pistache	Light green	Pink with green tip
7. Cheers	Light pink	Yellow with green tip
8. Marquis	Light pink and green	Yellow with green tip
9. Cassis	Light purple	Dark purple
10. Terra	Light brownish red	Pink with green tip
11. Sunglow	Dark pink	Cream with yellow tip
12. Simba	White with green at lower part	Light pink with yellow tip

CROP REQUIREMENTS

Soil

Anthurium requires a good well drained soil. Anthuriums have thick succulent roots. These roots will rot readily when and if the potting medium is poorly drained and starving for oxygen. For established specimens, any high quality sphagnum peat- based container mix can be used. Anthurium plants are different than other aroids like spathiphyllum and aglaonema. It is best to add one –third volume organic potting media or a coarse grade perlite. This will help to drain the soil and develop a healthier root system.

Media

Anthuriums grow best in a well aeriated medium with good water retention and good drainage. A good medium needs to be able to anchor the roots and stem so that the plant will not topple over as it grows larger, yet provide sufficient moisture, nutrients, and aeration to the plant. Organic matter (ie. wood shavings, cocopeats, tree fern,peat,decomposed oil palm bunch) or an artifical medium (ie. rockwool, polyfenol foam) can serve as a good medium to anchor roots for plant growth and flower production.

Water

As a general rule of thumb Anthuriums like to stay evenly moist, especially when they are actively growing. Some of the bird-nest types have a more leathery leaf and seem to handle drought conditions better. It is recommended to check the root system to make sure that the plant is not pot bound as they will dry out fast. They may not show signs right away from drying out, but this will put undo stress on the plant, causing tip burn and root damage. When Anthuriums are over – watered the plants are affected by the yellowing of the older leaves which hang on the plant.

Light

Anthuriums as a rule (indoor) will take about as much light as can be provided them with but not direct sunlight. Lower levels of light will slow down or cease flower production. The foliage type species will tolerate lower of light levels as they grow in some of the shadiest areas in their natural habitat. Leaves emerging under lower light may stretch and or become distorted. In a commercial nursery, a 70% - 80% shade is provided.

Spacing

The most common bed planting distance is 30 cm x 30 cm plantings providing approximately 50,000 plants per ha. Dense plantings decrease air circulation and hinder chemical spray penetration; leaf pruning and spraying schedules must be rigidly followed to keep disease and insect damage at a minimum. An anthurium plant may be pruned to a minimum of four leaves without any adverse effect on flower production and quality. Anthuriums can also be grown in containers such as plastic pots or bags. For 25 cm plastic pots, approximately 29,700 to 32,200 plants per hactare can be cultivated.

Planting distances varies with the vigor of the cultivar, amount of shade and the planting rotation plan. Rain shelter houses can accommadate higher densities because of improved disease control.

Shading and Protective Structures

All anthuriums thrive best in a warm and humid environment with 75% shade. In practice, they are normally grown under netted structures and using fertigation system, which keeps pest risk at minimal level. Plastic sheets or silver shines are also used to cover soil surfaces also helps to control weeds. The use of fertigation systems and plastics sheets or silver shines can also avoid soil contamination.

They require an organic base growing media for optimum performance. Keep the plant well-watered, misted and away from direct sunlight.Shading from sunlight is necessary for normal growth for anthuriums. The degree of shading varies with the cultivar, the age of the plant, and the climate under which it is grown. The shade requirements usually range from 55 % to 80% of full sunlight. Insufficient shading often results in damage to leaves and flowers, and may cause plant death. Damage to flowers include fading of spathes (especially pastels) and burning of spadices. Growers use various methods to provide shade. Many producers use shade structures supported with lumber or galvanized pipes and wire. They provide uniform shade; permit plants to be planted immediately after construction; reduce bird, insect, and wind damage; provide maximum freedom of work space; and provide more flowers per unit area.

To minimize infection of the bacterial blight disease and mechanical damage due to rain, some growers are now growing anthuriums under polyethylene plastic in combination with shade cloth to keep rain water off the anthurium.

Irrigation

Anthuriums needs daily watering when rains are scarce. Hence a perennial water system has to be available as a prerequisite to establishing a farm. Water supplied to plants should be of good quality.

Fertilizer Application

For plants grown on media such as coconut husk, brick pieces, tile pieces etc. fertilizers having a N:P:K ratio of 20:20:20 may be sprayed as a foliar application. During flowering rations may be changed to 6:14:7 or 20: 30:20. Fertilizers with the elements Ca, Mg and other microelements should also be added in liquid form.

If plants are grown on media with leaf mould or compost and sand, solid fertilizers are used in the following amounts:

Ammonium sulphate	-	30 kg
Super phosphate	-	55 kg
Muriate of potash	-	15 kg

All three fertilizers should be mixed and a mixture of 8 gm should be applied per plant.

Other Fertilizer Requirements

Anthuriums should be given a foliar fertilizer at a rate of 5-10gms/ 5litre once week. An organic fertilizer given at a rate of 5-10 gm/plant every 2 weeks. Fertigation system is used nowadays for irrigation as well as for fertilizer application. Fertigation system also helps to overcome the problem of infestation of bacterial diseases.

Climatic requirements
Anthuriums may be grown in the wet and intermediate zone up to an elevation of 1500 m.

Anthuriums thrive well when:-

a) Night temperature is never lower than 60^0F (15^0C)
b) Maximum day temperature is about 70 – 86^0F (35^0C)
c) Relative humidity is 70-80%
d) Shading requirements ranging from 70–80%

PEST MANAGEMENT

Sanitation

Since the commercial varieties are introduced from other countries and grown in controlled environments such as fertigation and protective structures, they are relatives free from pests and diseases at the moment.

A control method has been developed employing sanitation measures (removal of systemically infected plants and leaves) and using fertigation system of growing anthuriums in plastic bags or pots. The plastic bags or pots must not be in contact with the soil.

HARVEST AND HANDLING

Harvesting

Anthurium starts producing flowers 8 months after planting in the field. On an average 6-8 flower stalks/plant/ year are produced. Generally the flowers is ready to be cut and harvested when half of the spadix change color.

Maturity

The proportion of open flowers on the spadix determines the maturity of anthurium flowers. In immature anthuriums, the spadix is smooth. Flower opening starts at the spadix and proceeds upwards; spadices with open flowers are noticeably rough. Although producers in some countries harvest anthuriums when as little as 20% (1/5) of the spadix is rough, other growers harvest flowers when only 1/4 of the spadix is still smooth (3/4 of the flowers are therefore open). Harvesting anthuriums when more mature increases overall vase life.

Harvesting and Post – Harvest Handling

The flowers are removed from the plant using shears or secateurs.

Grading

Althought there are no formal grade standards for anthuriums, top quality implies long stems, uniformity of color and size, proper maturity, glossiness of the spathe and free from any damage or disease.

Postharvest Life

Reduced post- harvest life is apparently associated with clogging of the vascular tissue in the stem. Silver nitrate (together with distilled water) treatment of the stem reduces this blockage and helps maintain water conducting tissue, thereby increasing post-harvest life by up to 50%. For air shipment it is advisable to use dry packing procedures and silver nitrate treatment.

Reduced water loss from the flower by wax coating also increases post-harvest life up to 30%. The best wax of those tested was a carnauba base wax (FMC –819).Both of these treatments (silver nitrate and wax) has commercial growers who have used the wax treatment say that the added sheen is very attractive.

Packing

Anthurium are normally packed individually. They are commonly packed in shredded paper. Major damage during transportation is the result of spadices puncturing the spathe of neighboring flowers in the pack. Many producers now sheathe the flowers is small plastic bags and pack the anthuriums more densely in the box.

Chilling Injury

Anthuriums are very sensitive to “chilling” injury. Holding the flowers for any length of time at temperature below 10^{o} C (50^{o} F) will induce purpling, browning and then necrosis. Anthuriums should therefore never be pre-cooled with other flowers, nor held in low temperature cool rooms.

Storage

Anthuriums shipped in mixed loads at low temperatures should be protected from chilling exposure by appropriate insulation (for example wrapping the flowers in paper and packing them in an insulated box). Anthurium flowers can be stored for at least one week if packed in moist shredded paper and held at 16^{o} C (60^{o} F).

Yield

Flowers can be harvested 11/2 – 2 years after initiation of the nursery. Harvesting of flowers can be continuously for five years from the same plantation.

Annual flower production:

Year	Production / Ha
1	No flowers produced
2	250,000 flowers
3	300,000 flowers
4	350,000 flowers
5	350,000 Flowers

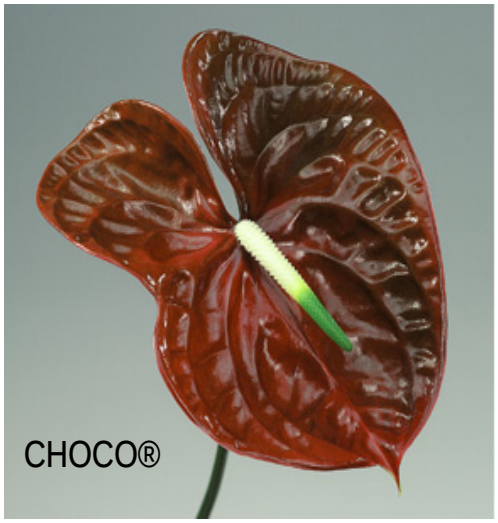
Uses

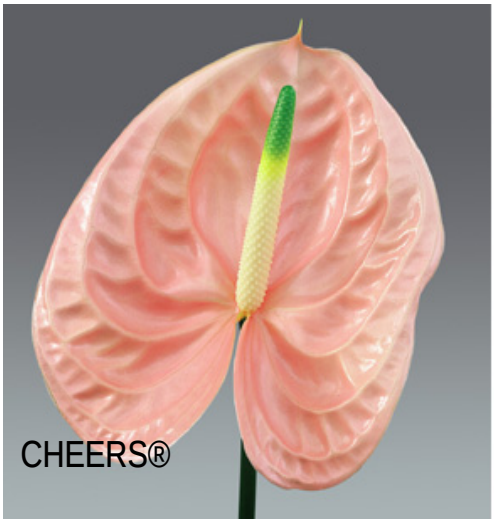
Anthurium flowers are generally used in flower arrangements and Ikebana.

REFERENCES:

1. http://agrolink.moa.my/doa/bdc/ecomimicanthurium.html
2. P.Y.Yau (1992) Anthurium production in Malaysia. Crop Technology. volume 8(1992). MARDI

SOME POPULAR VARIETIES FOR CUT FLOWER PRODUCTION





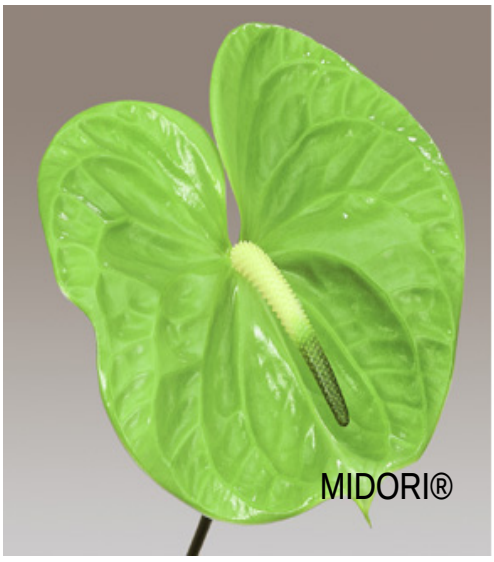
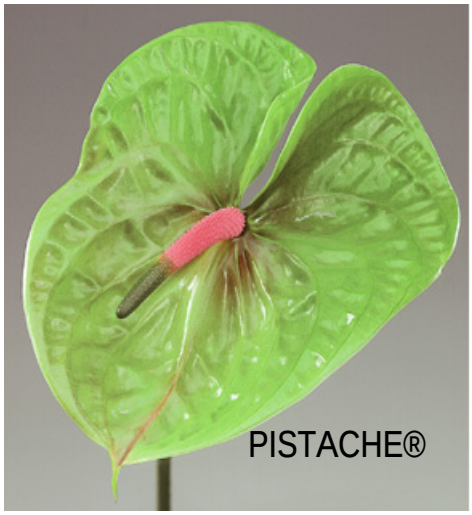
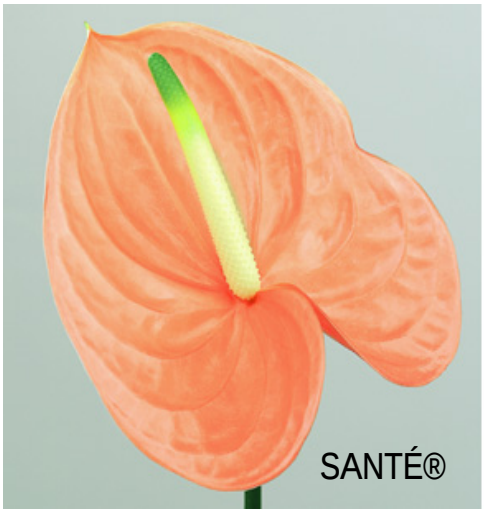


Photo: www.anthura.com





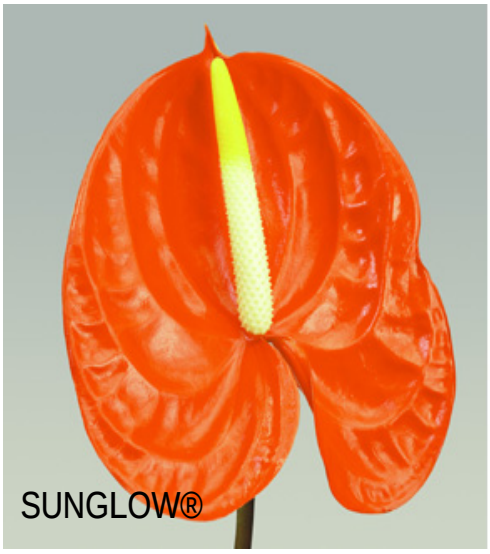


Photo: www.anthura.com

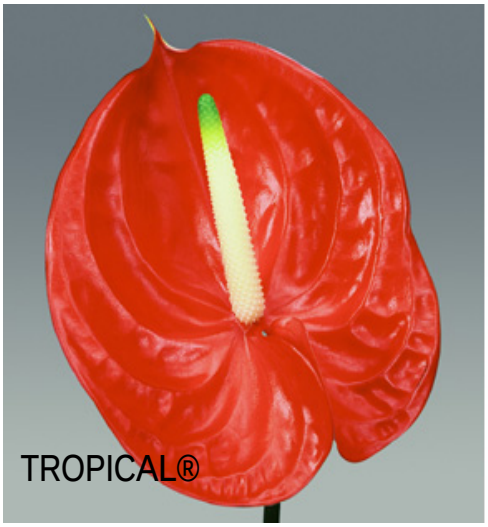


Photo: www.anthura.com

PRODUCTION AREAS

Source : Liang Heng Agriculture Farm, Cameron Highlands, Pahang

Photo: Liang Heng Agriculture Farm, Cameron Highlands, Pahang

Annex I

DISEASES LIST OF ANTHURIUM

DISEASES LIST ANTHURIUM IN MALAYSIA

	Genus	Species	Order	Family	Common name	Parts Affected	Verification Method(Ref.2)	Distribution	Status K.G.Singh(1980)	Status upto 2003
1		***No further details***			Mosaic virus		L1	PM	A(5)(K.G.Singh,1980)	A(1) no pest records
2	*Colletotrichum*	*Gloeosporoides*	No information	No Information	Spadix rot / spadix blight	Leaf	S1, C2	PM	A(1) No pest records	P(8) but managed (DoA 2004)
3	*Xanthomonas*	*Campestris*	No information	Pseudomonadaceae	Blight of Anthurium / Bacterial leaf spot	Leaves	S1, C2	PM	A(1) No pest Records	P(8) but managed (DoA 2004)
4	*Fusarium*	*Sp.*	Hypocreales	No Information	Basal Stem Rot	Basal Stem	S1, C2	PM	A(1) No pest records	P(8) but managed (DoA 2004)

Reference:

1. K.G.Singh (1980), A Check List of Host And Disease In Malaysia. Ministry of Agriculture.
2. Survey report on pests and Diseases of Flowers(2004). Crop Protection & Plant Quarantine, Department of Agriculture (DoA),

CODE

Distribution:

PM : Peninsular Malaysia
SWK : Sarawak
SB : Sabah

VERIFICATION CODE

C1 : Collection center
C2 : Compendium
L1 : Literature /Jurnal/Publication
P1 : Personal communication
S1 : Survey

STATUS CODE

A(1) Absent : no pest records
A(2) Absent: pest no longer present
A(3) Absent : pest records invalid
A(4) Absent: pest record unreliable
A(5) Absent : Intercepted only
P(1) Present : In all parts of the area
P(2) Present : only in some area
P(3) Present :except in specified pest free areas
P(4) Present : in all parts of the area where host crop(s) are grown
P(5) Present : only in some area where host crop(s) are grown
P(6) Present: only in protected cultivation
P(7) Present : seasonally
P(8) Present: but managed
P(9) Present : subject to official control
P(10) Present : under eradication
P(11) Present : at low prevalence
T(1) Transience: non-actionable
T(2) Transience : actionable, under surveillance
T(3) Transience: actionable, under eradication

Annex II

DISEASES FACT SHEET OF ANTHURIUM

1.0 DISEASES FACT SHEET ANTHURIUM

Species name	No further details
Common name	**Mosaic virus**
Taxonomy	No further details
Other names	No further details
Distribution	No further details
Status	No further details
Biology, Ecology & Morphology	No further details
Affected Plant Stages	No further details
Affected Plant Parts	No further details
Symptoms	No further details
Damage	No further details
Hosts	No futher details
References	1. K.G.Singh (1980), A Check List of Host And Disease In Malaysia. Ministry of Agriculture

2.0 DISEASES FACT SHEET ANTHURIUM

Species name	*Colletotrichum gloeosporoides* Penz.
Common name	▪ Colletotrichum leaf spot (A.R Chase, 1997) ▪ Anthracnose (A.R Chase, 1997) ▪ Spadix blight (A.R Chase, 1997) ▪ Spadix rot (HiloWeb,2003) ▪ Blacknose (HiloWeb,2003)
Domain	Eukaryota
Kingdom	Fungi
Phylum	'Mitosporic fungi' (Anomorphic fungi)
Class	No information
Order	No information
Family	No information
Other names	*Colletotrichum gloeosporoides* Penz.,(anamorph) *Glomerella cingulata (Stonem.*) Spauld & Schrenk (teleomorph)
Distribution	▪ Peninsular Malaysia - Leaf (personal com.)
Status	Minor
Biology, Ecology & Morphology	Identified as *Colletotrichum gloeosporioides* Penz., the anamorphic state of *Glomerella cingulata* (Stonem.) Spauld & Schrenk. The teleomorph belongs to the family Polystigmataceae, under the class Ascomycetes. *C. gloeosporoides* accounts for the majority of anthracnose disease of foliage plants. Extremely variable, making a standardized description generally useless. Conidia 9-24x3-4.5 µm are straight and obtuse at the apex. Appressoria 6-20x4-12 µm are clavate or irregular. Most isolates of *C. gloeosporoides* from foliage plants produce setae and are pale gray to black with with orange masses of conidia. Both the perfect and the imperfect stages are frequently isolated from a single plant, with *C. gloeosporoides* found more often than *Glomerella cingulata.*
Affected Plant Stages	▪ Vegetative growing stage
Affected Plant Parts	▪ Leaves ▪ Flowers ▪ Petiole & pedicels

Symptoms	1. Root: no information. 2. Leaves: On anthurium leaves, the disease occurs as discrete, round, necrotic leaf spots, or irregular-shaped, necrotic patches usually near the margin . Leaf spots have pale grayish-brown centres with more or less concentric rings of tiny black spots which represent the fruiting bodies (acervuli) of the fungus, and dark brown necrotic margins usually surrounded by a pale yellow halo. The fungus may infect leaves following an injury. 3. Flowers: the disease affects the individual flowers on the spadix. Infection starts as a tiny, dark spot that expands to a triangle or other angular shape depending on the number and pattern of sepals infected. Each infection site usually remain isolated, is surrounded by adjacent helthy tissue, and may be scattered individually. 4. Petiole & pedicels: these plant parts are also susceptible and develop elongated, diamond-shaped lesions.
Damage (+ severity)	Infected leaves can be prematurely aborted. Infection on the spadix is the common cause for flower rejection.
List of Hosts	*Albizia falcate* Backer, *A/eurites montana* E.H. Wilson, *Allium cepe* Tourn., *A. porrum* L., *Araucaria cunninghamii* Sweet., *Arundina graminifolia* Schlecht., *Brassica chinensis* L., *Bauhinia* sp., *Brassica o/eracea* L. var. *capitata* L., *Ca/opogonium mucunoides* Desv., *Carica papaya* L., *Coffee* sp., *Crota/aria anagyroides* H.B.K., *Derris elliptica* Benth., *Dioscorea* sp., *Durio zibethinus* Murr., *E/aeis guineensis* Jacq., *Hevea brasiliensis* Muell. Arg., *Hibiscus escu/entus* L., */xora* sp., *Jatropha curcas* L. *Mangifera foetida* Lour., *Passiflora edulis* Sims., *Pha/aenopsis amabilis* Blume, *P. vio/acea* Teijsm. & Binn., *Piper belle* L., *P. nigrum* L., *Pisum sativum* L., *Spathoglottis* sp., *Theobroma cacao* L., *Uncaria gambir* Roxb., *Vanilla p/anifolia* Andr. (Singh,1980). *Dieffenbachia maculata*, *Dionaea muscupula*, *Graptopetalum paraguayense*, *Sedum morganianum*, *S. pachyphyllum*, *Sempervivum tectorum* (A.R Chase, 1997)
Control	1. Cultural controls: minimization of watering and wounding. Choice of resistant cultivar. 2. Chemical control:the most common method control of anthracnose of foliage plants has been the application of fungicide on a preventive schedule. The following compounds have control the disease on foliage plants – chlorothalonil, mancozeb, benomyl. Chlorothalonil and mancozeb provide superior control and are safely used on wide variety of foliage crops.
References	1. CABI. (2002 Edition).Crop Protection Compendium . 2. A.R. Chase. (1997).Compendium of Ornamental Foliage Plant Disease. Page 9, 20

	3. K.G.Singh,(1980). A Check List of Host and Disease in Malaysia. Page 202 4. Pakej Teknologi Bunga Anthurium, Jabatan Pertanian, Jun 1998 5. http://hiloweb.com/webman/adbb.html

3.0 DISEASES FACT SHEET ANTHURIUM

Species name	*Xanthomonas campestri*s pv dieffenbachiae.
Common name	▪ Bacterial leaf spot (A.R Chase, 1997) ▪ Blight of Anthurium (A.R Chase, 1997)
Domain	No information
Kingdom	Bacteria
Phylum	No information
Class	No information
Order	No information
Family	Pseudomonadaceae
Other names	No information
Distribution	▪ Peninsular Malaysia – leaves (personal com.)
Status	Minor
Biology, Ecology & Morphology	*Xanthomonas campestris* cause diseases of a wide variety of foliage plants. Single rods measure 0.3-0.4 x 1.0-1.5 µm and have a single polar flagellum. Strains are aerobic and liquefy both gelatin and blood agar. The optimum pH for growth is 6.4-6.8 and maximum and minimum temperatures for growth are 37-38^{o} and 5^{o} respectively. This bacteri spreads through transplanting infecte plants into uncontaminated areas, splashing rain, or irrigation water that moves bacteria from an infected part of one plant to yaoung leaves, or open wounds od adjacent healthy plants with hand, tools, people walking and brushing infected plants, wet clothing, rain wear, infected soil on footwear and vehicle.
Affected Plant Stages	▪ Vegetative growing stage
Affected Plant Parts	▪ Leaves ▪ Spathe & stem
Symptoms	Leaves & spathe: On anthurium, symptoms of Xanthomonas leafspot are irrigularly v-shaped lesions on the edge of the older leaves. Lesions confined to leaf margin when infection occurs through hydathodes.. Usually the symptom started to show on young leaves and open wound were most vulnerable to infection water-soaked spots surrounded by very slight yellowing were early symptoms, noticeable on lower surface leaves. As it progresses, mature lesions are black and surrounded by a bright yellow border, and adjacent tissue is chlorotic.Stem: Stem infection is characterized by blackening of the stem and leaf sheaths covering young petiole bases. The bacteria invades water-conducting tissue and interferes with the translocation of water and nutrients, causing pale bleach flowers and prematurely yellowing young leaves.

Damage (+ severity)	Infected leaves can be prematurely yellowing, causing flowers pale bleach.
List of Hosts	Brassica oleracea L. (Singh,1980). Aglonaema commutatum, A. pictum, A. pseudobracteatum, A. roebelinii, Caladium sp, Dieffenbachia spp., Philodendron spp., Syngonium podophyllum, Xanthosoma caracu, X. sagittifolium (A.R Chase, 1997)
Control	1. Cultural controls: Sanitize the field. Remove diseased leaves and systemically infected plants. Handle these plants with gloves to avoid contamination of other stock. Harvest flowers first from areas with the least blight and then in those with most blight to minimize spread.Minimization of watering and wounding. Choice of resistant cultivar. 2. Chemical control: Start a control program as soon as the symptom occurs and the cause of the disease ie verified. Spray weekly with antibiotic (oxytetracycline) for 6-8 weeks only. Do not continue to use antibiotics routinely, since resistance can develop. Disinfest tools with 70% alcohol for at least 3 minnits or with another suitable disinfestant.
References	1. A.R. Chase. (1997).Compendium of Ornamental Foliage Plant Disease. Page 58-60 2. K.G.Singh,(1980). A Check List of Host and Disease in Malaysia. Page 257. 3. http://hiloweb.com/webman/adbb.html

4.0 DISEASES FACT SHEET ANTHURIUM

Species name	*Fusarium* sp.
Common name	▪ Basal stem rot (Pakej Teknologi Bunga Anthurium, Jabatan Pertanian, Jun 1998)
Domain	Eukaryota
Kingdom	Fungi
Phylum	Anomorphic fungi
Class	Hyphomycetes
Order	Hypocreales
Family	No information
Other names	No information
Distribution	▪ Peninsular Malaysia – basal stem (personal com.)
Status	Minor
Biology, Ecology & Morphology	Mycelium extensive and cottony in culture, often with some tinge of pink, purple or yellow, in the mycelium or medium; conidiophores variable, slender and simple, or stout, short, branched irregularly or bearing a whorl of phialides, single or grouped into sporodochia; conidia (phialospores) hyaline, variable, principally of two kinds, often held in small moist heads; macro conidia several-celled slightly curved or bent at the pointed ends, typically canoe-shaped; microconidia 1-celled, ovoid or oblong, borne singly or in chains; some conidia intermediate, 2- or 3-celled, oblong or slightly curved; parasitic on higher plants or saprophytic on decaying plant material. (CABI,2002)
Affected Plant Stages	▪ Vegetative growing stage ▪ Matured plant
Affected Plant Parts	▪ Basal stem
Symptoms	▪ Basal stem: Plant wilting and leaves yellowing. Irregular foliar spots develop,and a brown clorosis appears in basal portion of the stems. Plant death generally results from this infection.
Damage (+ severity)	No information

List of Host	*Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita, Cyclamen*, *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), Elaeis, *Eleusine indica* (goose grass), *Euphorbia esula* (leafy spurge), *Elettaria cardamomum* (cardamom), *Eucalyptus tereticornis* (forest red gum), Fragaria, *Gerbera jamesonii* (African daisy), *Ginkgo biloba* (fossil tree), *Gladiolus* hybrids (sword lily), *Glycine max* (soyabean), *Gossypium* (cotton), *Helianthus annuus* (sunflower), *Hibiscus cannabinus* (kenaf), *Hordeum vulgare* (barley), *Ipomoea batatas* (sweet potato), *Lactuca sativa* (lettuce), *Lagenaria siceraria* (bottle gourd), *Lathyrus sativus* (grasspea), Luffa acutangula (angled luffa), *Lupinus* (lupins), *Lycopersicon esculentum* (tomato), *Manihot esculenta* (cassava), *Mangifera indica* (mango), Musa (banana), *Nicotiana tabacum* (tobacco), *Saccharum officinarum* (sugarcane), *Solanum tuberosum* (potato), Sorghum, *Spinacia oleracea* (spinach), *Vigna unguiculata* (cowpea), *Zea mays* (maize), *Zingiber officinale* (ginger). (CABI 2002).
Control	1. Reduction of applications of water greatly reduces the spread of the pathogen. 2. Soil drenches of benomyl at 1.0 g a.i per liter, applied every 2 weeks for 4-5 months, gave excellent diseses control in plants treated either before or after symptom development.
References	1. Barnett H.L & Hunter B.B., Illustrated Genera of Imperfect Fungi Burgess Publishing Company, (1972) p126 2. A.R. Chase. (1997).Compendium of Ornamental Foliage Plant Disease. Page 26 3. CABI. (2002 Edition).Crop Protection Compendium . 4. Pakej Teknologi Bunga Anthurium, Jabatan Pertanian, Jun 1998 5. Singh K.G (1980).A Check List of Host and Disease in Malaysia, p 63

Annex IV

PESTS (NEMATODE) LIST OF ANTHURIUM

PESTS (NEMATODE) LIST ANTHURIUM IN MALAYSIA

Genus		Species	Order	Family	Common name	Parts Affected	Verification Method(Ref.2)	Distribution	Status A.Yunus(1980)	Status upto 2003
1	*Radopholus*	*similis*	Tylenchida	Pratylenchidae	Nematode root rot	Root	L1	PM, Sa, Swk	A(1) no pest records	P(8), but managed (MARDI 1992, DoA 1999)
2	*Paratylenchus*	*Sp.*	No further de	Pratylenchidae	nematode	Root	L1	PM	A(1) No pest records	P(8) but managed (MARDI 1992,)
3	*Retylenchulus*	*Reniformis*	Tylenchida	Hoplolaimidae	Reniforme nematode	Leaves, roots, vegetative organs, whole plant	C2, S1	PM, Sa, Swk	A(1) no pest records	P(8) but managed (DoA, 1999)
4	*Meloidogyne*	*Sp.*	Tylenchida	Heteroderidae	Root-knot nematode	Leaves, roots, whole plant	C2, S1	PM, Sa, Swk	A(1) No pest records	P(8) but managed (DoA 1999)
5	*Helicotylenchus*	*Sp.*	Tylenchida	Hoplolaimidae	Spiral nematode	Leaves, roots, vegetative organs, whole plant	C2, S1	PM, Sa, Swk	A91) No pest records	P(8) but managed (DoA 1999)
6	*Criconemella*	*Sp.*	Tylenchida	Criconematidae	Ring nematode	Roots, Whole plant	C2, S1	PM, Sa, Swk	A(1) No pest records	P(8) but managed (DoA 1999)
7	*Pratylenchus*	*Brachyurus*	Tylenchida	Pratylenchidae	Meadow nematode	Leaves, roots, seeds, stems, whole plant	C2, S1	PM, Sa, Swk	A(1) No pest records	P(8) but managed (DoA 1999)

Reference:

1. K.G.Singh (1980), A Check List of Host And Disease In Malaysia. Ministry of Agriculture.
2. P.Y.Yau. (1992), Anthurium Production in Malaysia, Crop Technology (1992) MARDI.
3. Annual Report.(1999) Crop Protection & Plant Quarantine, Department of Agriculture.

CODE

Distribution:
PM : Peninsular Malaysia
SWK : Sarawak
SB : Sabah

Verification Code
C1 : Collection center
C2 : Compendium
L1 : Literature /Jurnal/Publication
P1 : Personal communication
S1 : Survey

Status Code
A(1) Absent : no pest records
A(2) Absent: pest no longer present
A(3) Absent : pest records invalid
A(4) Absent: pest record unreliable
A(5) Absent : Intercepted only
P(1) Present : In all parts of the area
P(2) Present : only in some area
P(3) Present :except in specified pest free areas
P(4) Present : in all parts of the area where host crop(s) are grown
P(5) Present : only in some area where host crop(s) are grown
P(6) Present: only in protected cultivation
P(7) Present : seasonally
P(8) Present: but managed
P(9) Present : subject to official control
P(10) Present : under eradication

P(11) Present : at low prevalence
T(1) Transience: non-actionable
T(2) Transience : actionable, under surveillance
T(3) Transience: actionable, under eradication

Annex V

PESTS (NEMATODE) FACT SHEET OF ANTHURIUM

1.0 PESTS (NEMATODE) FACT SHEET ANTHURIUM

Species name	*Radopholus similes Cobb, 1893) Thorne, 1949*
Common name	nematode root rot
Taxonomy	Domain :Eukaryota Kingdom : Metazoa Phylum : Nematoda Class : Secernentea Order : Tylenchida Family : Pratylenchidae
Other names	*Anguillulina acutocaudatus* (Zimmermann, 1898) Goodey, 1932 *Anguillulina biformis* (Cobb,1909) Goodey, 1932 *Anguillulina granulosa* (Cobb, 1893) Goodey, 1932 *Radopholus acutocaudatus* (Zimmermann, 1898) Siddiqi, 1986 *Radopholus biformis* (Cobb, 1909) Siddiqi, 1986 *Radopholus citrophilus* Huettel, Dickson & Kaplan, 1984 *Radopholus granulosus* (Cobb, 1893) Siddiqi, 1986 *Radopholus similis citrophilus* Huettel, Dickson & Kaplan, 1984 *Tetylenchus granulosus* (Cobb, 1893) Filipjev, 1936 *Tylenchorhynchus acutocaudatus* (Zimmermann, 1898) Filipjev, 1934 *Tylenchus biformis* Cobb, 1909 *Tylenchus similis* *Tylenchus granulosus* *Rotylenchus similis* *Anguillulina similis*
Distribution	Peninsular Malaysia. (1992, MARDI)
Status	Minor but managed
Biology, Ecology & Morphology	Male Oesophagus and spear degenerate; median bulb and valvular apparatus indistinct, spear without distinct knobs. Lip region elevated, 4-lobed, with lateral lips considerably reduced, not strongly sclerotized, with 3-5 annules posteriorly. Hemizonid just anterior to excretory pore which is usually 2-3 body widths behind median oesophageal bulb. Single testis, outstretched anteriorly; spermatocytes in 3 rows followed by 5; spermatozoa rod-like. Bursa coarsely crenate, enveloping about two thirds of tail. Spicules strongly cephalated, 18-22 µm long, with pointed distal ends. Gubernaculum rod-like, protrusible, with distinct sharp claw-like titillae at distal end. Female Body straight to slightly arcuate ventrally; cuticle distinctly annulated. Lateral field with 4 incisures, not areolated except towards extremities, arising from near median oesophageal bulb and ending near tail terminus; inner incisures coalescing near middle of tail. Lip region hemispherical, sometimes offset, usually with 3-4 annules; sclerotization strong; dorsal and ventral arms of framework not wider than submedians; lips 6, equal. Anterior cephalids just posterior to labial sclerotization. Spear about 18 µm long, with well developed round basal knobs which are usually indented anteriorly; dorsal knob sometimes appearing larger than subventrals.

Affected Plant Stages	**Affected Plant Stages:** Seedling stage, vegetative growing stage, flowering stage, and fruiting stage.
Affected Plant Parts	**Affected Plant Parts:** Whole plant, leaves, roots, and vegetative organs.
Hosts	**Primary hosts:** Musa (banana), *Musa paradisiaca* (plantain), Citrus, *Piper nigrum* (black pepper), Coffea (coffee), *Zea mays* (maize), *Saccharum officinarum* (sugarcane), *Ananas comosus* (pineapple), *Arachis hypogaea* (groundnut), *Anthurium andreanum*, *Camellia sinensis* (tea), *Cocos nucifera* (coconut), *Coffea arabica* (arabica coffee), *Coffea canephora* (robusta coffee), *Daucus carota* (carrot), Dioscorea (yam), *Lycopersicon esculentum* (tomato), *Zingiber officinale* (ginger).
Symptoms	Leaves affected by mites are speckled or stripped and in severe cases, the leaves become bronze or brown with scarified markings. In severe cases, the leaves turn yellow and drop prematurely. The plants become stunted but seldom die.
Control	Should be control at an earlier stage using fenamiphos at a rate of 2-4gm/plant.
References	1. P.Y.Yau(1992) Anthurium Production in Malaysia. Another Crop Technology. Jil 8(1992) 2. Crop Protection Compendium .CAB International (2002) 3. Annual Report.(2000) Crop Protection & Plant Quarantine, Department of Agriculture.

2.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species name	*Paratylenchus* sp.
Common name	root lesion nematode
Taxonomy	Domain: Eukaryota Kingdom: Metazoa Phylum: Nematoda Family: Pratylenchidae
Other names	No further details
Distribution	Peninsular Malaysia (1992, MARDI)
Status	Minorbut Managed
Biology, Ecology & Morphology	Small nematodes, under 0.5 mm. long. Female may swell slightly and become sessile parasite. Head conical or rounded, usually without annules, rarely offset in any way. Spear strong, variable in length but may be relatively very long, fore part longer than shaft; basal knobs rounded. Procorpus and median bulb amalgamated, containing large crescentic valve plates. Isthmus narrow but relatively long, leading to a rounded or spathulate terminal bulb. Body distinctly annulated; lateral field usually with 4 incisures. Vulva posterior, protected on either side by a membrane of cuticle; leading into a vagina, which stretches halfway, or more into the body. Uterus composed of a number of large cells, sometimes with an open chamber adjoining the vagina; a spermatheca, packed with sperms, present apparently as a diverticulum of the upper end of the uterus. Ovary outstrectched, prodelphic; no post-vulval sac. Anus often obscure, tail conical to a variously shaped point. Body becomes C-shaped when killed by heat. Male more slender, spear and oesophagus usually faint and ill-defined or non-existant. Spicules long, slender and pointed; gubernaculum short. At the anus a short sheath usually protrudes, which may have a process at its posterior edge. Tail with slight or without bursa. Male tail conoid to a variously shaped point.
Affected Plant Stages	No further details
Affected Plant Parts	No further details

Hosts	**Primary hosts:** Cucurbitaceae (cucurbits), Poaceae (cereals), Ananas comosus (pineapple), Cajanus cajan (pigeon pea), Dioscorea (yam), Lycopersicon esculentum (tomato), Phaseolus (beans), Solanum melongena (aubergine). **Secondary hosts:** turfgrasses (turfgrasses).
Symptoms	Leaves affected by mites are speckled or stripped and in severe cases, the leaves become bronze or brown with scarified markings. In severe cases, the leaves turn yellow and drop prematurely. The plants become stunted but seldom die.
Control	Should be control at an earlier stage using fenamiphos at a rate of 2-4gm/plant.
References	1. P.Y.Yau(1992) Anthurium Production in Malaysia. Another Crop Technology. Jil 8(1992). MARDI 2. Crop Protection Compendium .CAB International (2002) 3. http://nematode.unl.edu/paratysp.htm

3.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species name	*Rotylenchulus reniformis* Linford & Oliveira, 1940
Common name	Reniforme nematode
Taxonomy	Domain: Eukaryota Kingdom: Metazoa Phylum: Nematoda Family: Hoplolaimidae
Other names	*Leiperotylenchus leiperi* Das, 1960 *Rotylenchulus leiperi* (Das) Loof & Oostenbrunk, 1961 *Rotylenchulus queirozi* (Lordello & Cesnik) Sher, 1961 *Rotylenchulus stakman*i Husain & Khan, 1965 *Spyrotylenchus queirozi* Lordello & Cesnik, 1958
Distribution	Malaysia: widespread (CABI 2003) Peninsular Malaysia: present, no further details (CABI/EPPO 2003)
Status	Minor
Biology, Ecology & Morphology	*R. reniformis* is a soil inhabiting semi-endoparasite of roots. It occurs in many different non-flooded soils but is more frequently found in heavier clay silts and clays in contrast to the root knot nematodes . **Life Cycle** *R. reniformis* has four juvenile stages, an immature female and mature female/male stages. Mature females lay single-celled eggs, which develop into the first stage juveniles that moult into the second-stage juvenile before emerging from the egg. Further moults occur producing the third and fourth juvenile stages, all of them retaining the cuticles of the previous stages. None of these juvenile stages are parasitic and they do not feed on the plant roots. The final moult produces an immature vermiform female or male. *R. reniformis* has both males and females but is also known to reproduce parthenogenetically. Males are not parasitic. The vermiform immature female is the infective stage and it partly penetrates the cortex of host plant root. A permanent feeding site in the root endodermis is developed at the head of the nematode and it becomes sedentary. The posterior body of the female remains protruding from the root and swells as the nematode reaches maturity producing a very characteristic kidney or reniform shape. The swollen females lay eggs into a gelatinous matrix, which covers the body on the surface of the root. The life cycle from egg to egg can be as short as 3 weeks and is affected by the host and environmental conditions, in particular temperature. **Affected Plant Stages** No further details **Affected Plant Parts** No further details

	Symptoms Infected pineapple plants show poor growth, reddish leaves and are less upright than healthy plants. Plants that are very heavily infested may collapse and die. Seedling emergence is delayed in some vegetables, tobacco and legumes. The nematodes cause stunted growth associated with leaf chlorosis in susceptible crops. In sweet potato they may cause surface cracking of tubers.
Hosts	**Primary hosts:** *Ananas comosus* (pineapple), *Brassica oleracea* var. *capitata* (cabbage), *Cajanus cajan* (pigeon pea), *Cucumis melo* (melon), *Glycine max* (soyabean), *Ipomoea batatas* (sweet potato), Musa (banana), *Solanum melongena* (aubergine), *Vigna unguiculata* (cowpea), Cucurbitaceae (cucurbits), Citrus, *Lycopersicon esculentum* (tomato), Phaseolus (beans). **Secondary hosts:** *Artocarpus altilis* (breadfruit), *Arachis hypogaea* (groundnut), *Averrhoa carambola* (carambola), *Beta vulgaris* (beetroot), Brassica oleracea (cabbages, cauliflowers), *Camellia sinensis* (tea), Cajanus, *Carica papaya* (papaw), *Citrus sinensis* (navel orange), *Citrullus lanatus* (watermelon), *Coffea arabica* (arabica coffee), *Coffea liberica* (Liberian coffee tree), *Cucumis sativus* (cucumber), *Cucurbita moschata* (pumpkin), *Daucus carota* (carrot), *Helianthus annuus* (sunflower), *Lactuca sativa* (lettuce), *Manihot esculenta* (cassava), *Mangifera indica* (mango), *Nicotiana tabacum* (tobacco), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Piper betl*e (betel pepper), *Piper nigrum* (black pepper), *Prunus armeniaca* (apricot), *Prunus domestica* (plum), *Prunus persica* (peach), *Sansevieria trifasciata* (snake plant), *Solanum nigrum* (black nightshade), *Solanum tuberosum* (potato), *Syzygium malaccense* (malay-apple), *Theobroma cacao* (cocoa), *Triticum aestivum* (wheat), *Zea mays* (maize), *Allium sativum* (garlic), *Amaranthus dubius* (Spleen amaranth), *Anacardium occidentale* (cashew nut), *Citrus limon* (lemon), Coffea (coffee), Capsicum (peppers), *Capsicum annuum* (bell pepper), *Gladiolus hybrids* (sword lily), Hemerocallis (daylilies), *Zingiber officinale* (ginger).
Control	1. Nematicide : i) Oxamyl ii) Aldicarb iii) Carbofuran iv) Fenamiphos v) Triazophos vi) Isofenphos vii) Benfuracarb (A.G. Whitehead, 1998). Plant Nematode Control. *CAB International*
References	1. Annual Report 1999. Crop Protection and Plant Quarantine. 2. A.G. Whitehead (1998) Plant Nematode Control. *CAB International, 250-251* 3. Crop Protection Compendium – CAB International 2002 Edition 4. http://ucdnema.ucdavis.edu/imagemap/nemmap/ENT156HTML/E156phylo 5. K. Evans, D.L. Trudgill, J.M. Webster (1993) Plant Parasitic Nematodes in Temperate Agriculture. *CAB International 506-507*

4.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species Name	*Meloidogyne incognita* (Kofoid & White, 1919) Chitwood 1949
Common Name	root-knot eelworm root-knot nematode southern root-knot nematode
Phyllum	Nematoda
Class	Secernentea
Order	Tylenchida
Family	Meloidogynidae
Synonym	*Meloidogyne acrita* Chitwood, 1949 *Meloidogyne incognita* acrita Chitwood, 1949 *Oxyuris incognita* Kofoid & White, 1919
Distribution	[Malaysia] Peninsular Malaysia: present, Sabah: present, Sarawak: present, (CAB International, 2002)
Status	Minor
Biology & Ecology	**Life Cycle** At 21°C *M. incognita* took 37 days to complete its life cycle. Juveniles penetrate root tips, occasionally invading roots in the zone of root elongation. Invaded nematodes initiate the development of giant cells in the meristematic, cortical and xylem tissues of the root and galling of roots occurs. Third- and fourth-stage juveniles and young females occur after about 6-8 and 15 days, respectively. Adult females were observed after 20 days and egg laying commenced after 25 days. Field symptoms are typically of stunted, poorly growing plants with yellowing leaves. Infected root systems show characteristic knots or galls, the severity of which varies with the degree of nematode infection and species and variety of plant parasitized. Descriptors: Whole plant: dwarfing; early senescence. Leaves: abnormal colors; wilting. Roots: galls along length; reduced root system; swollen roots. **Affected Plant Stages**: Seedling stage, vegetative growing stage, flowering stage, and fruiting stage. **Affected Plant Parts**: Whole plant, leaves, and roots **Symptom** No information (Crop Protection Compendium – CAB International 2002 Edition)
Host	**Primary hosts** *Abelmoschus esculentus* (okra), *Anthurium* sp. (Anthurium), *Capsicum annuum* (bell pepper), *Carica papaya* (papaw), Coffea (coffee), *Coffea arabica* (arabica coffee), Cucurbitaceae (cucurbits) Fabaceae (leguminous plants), *Hibiscus cannabinus* (kenaf), *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato), *Medicago sativa* (lucerne),

	Mangifera indica (mango), *Oryza sativa* (rice), *Phaseolus* (beans), *Phaseolus vulgaris* (common bean), *Solanum melongena* (aubergine), Solanaceae. **<u>Secondary hosts</u>** *Amaranthus* (grain amaranth), *Ananas comosus* (pineapple), *Brassicaceae* (cruciferous crops), *Chrysanthemum* (daisy), *Cichorium* (chicory), *Cannabis sativa* (hemp), *Canna*, *Colocasia*, Cyperus (flatsedge), *Daucus carota* (carrot), *Dioscorea* (yam), *Gossypium* (cotton), *Ipomoea batatas* (sweet potato), *Manihot esculenta* (cassava), *Musa* (banana), *Musa paradisiaca* (plantain*), Prunus* (stone fruit), *Solanum tuberosum* (potato), *Xanthosoma* (cocoyam). (Crop Protection Compendium – CAB International 2002 Edition)
Control	2. Nematicide : i) Oxamyl ii) Aldicarb iii) Carbofuran iv) Fenamiphos v) Triazophos vi) Isofenphos vii) Benfuracarb (A.G. Whitehead, 1998). Plant Nematode Control. *CAB International*
References	6. Annual Report 1999. Crop Protection and Plant Quarantine. 7. A.G. Whitehead (1998) Plant Nematode Control. *CAB International, 250-251* 8. Crop Protection Compendium – CAB International 2002 Edition 9. http://ucdnema.ucdavis.edu/imagemap/nemmap/ENT156HTML/E156phylo 10. K. Evans, D.L. Trudgill, J.M. Webster (1993) Plant Parasitic Nematodes in Temperate Agriculture. *CAB International 506-507*

5.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species Name	*Helicotylenchus dihystera* (Cobb, 1893) Sher, 1961
Common Name	Common spiral nematode Spiral nematode Nematode, Common spiral
Phyllum	Nematoda
Class	Secernentea
Order	Tylenchida
Family	Hoplolaimidae
Synonym	*Aphelenchus dubius* var. peruensis Steiner, 1920 *Helicotylenchus crenatus* Das, 1960 *Helicotylenchus flatus* Roman, 1965 *Helicotylenchus nannus* Steiner, 1945 *Helicotylenchus paraconcavus* Rashid and Khan, 1974 *Helicotylenchus punicae* Swarup and Sethi, 1968 *Tylenchus dihystera* Cobb, 1893 *Tylenchus olaae* Cobb, 1906 *Tylenchus spiralis* Cassidy, 1930
Distribution	Malaysia: widespread Sarawak: present, (CAB International, 2002)
Status	Minor
Biology & Ecology	*H. dihystera* is basically an ecto- or semi-endoparasite of roots and large populations are found in the rhizosphere. Several cells are penetrated before feeding begins and walls are ruptured by the combination of forward body pressure and piercing by the stylet. After penetration, feeding from a single cell continues for several days, with alternating salivation and ingestion. The walls of the infested cells were lignified but there was no indication of nuclear proliferation, giant-cell formation or galling. The nematodes penetrated fibrous roots of sycamore seedlings behind their tips and at the intersection of lateral roots where they were found completely embedded in the cortical tissue, but in other root sections, they were semi-endoparasitic. The roots show small lesions around the point of nematode penetration and in cases of severe infestation there may be sloughing of the epidermal cells and part of the cortex. Nematodes fed in the region of maturation, avoided the root tip and preferred tap roots to secondary roots. They were generally in the cortex, coiled in the cells or uncoiled and lying parallel to the vascular tissue. There was some discoloration and lignin formation in the cell walls immediately around the nematodes but no giant cell formation. It reproduces by mitotic parthenogenesis and there is no indication of the presence of sperm in the spermatheca of females. Feeding by second-stage juveniles of *H. dihystera* on the host roots is essential for completion of the life cycle. Maximum activity of *H. dihystera* occurred between 20^{o}C and 30°C and velocity of locomotion and activity were much reduced between 5 and 10°C and 35 and 40°C. Mortality was greater at higher temperatures. It survived for 6 months in soil stored in plastic bags both at room temperatures (18-24°C) and in the refrigerator at 1.1^{o}C - 4.4°C.

	Affected Plant Stages : Vegetative growing stage. **Affected Plant Parts:** Whole plant, leaves, roots, and vegetative organs. **Symptom:** Whole plant: plant dead; dieback; dwarfing. Leaves: abnormal colors; yellowed or dead. Roots: soft rot of cortex; reduced root system; necrotic streaks or lesions; cortex with lesions. Vegetative organs: surface lesions or discoloration. (Crop Protection Compendium – CAB International 2002 Edition)
Host	*Allium cepa (*onion*), Ananas comosus (*pineapple*), Anthurium sp. (*Anthurium*), Arachis hypogaea (*groundnut*), Ipomoea batatas (*sweet potato*), Artocarpus altilis (*breadfruit*), Annona muricata (*soursop*), Apium graveolens (*celery*), Beta vulgaris (*beetroot*), Brachiaria mutica (*buffalo grass*), Camellia sinensis (*tea*), Cajanus cajan (*pigeon pea*), Cocos nucifera (*coconut*), CCarica, Carica papaya (*papaw*), Citrus aurantiifolia (*lime*), Citrus limon (*lemon*), Citrus x paradisi (*grapefruit*), Citrus sinensis (*navel orange*), Cinnamomum verum (*cinnamon*), Citrullus lanatus (*watermelon*), Calopogonium, Cymbidium, Coffea arabica (*arabica coffee*), Capsicum annuum (*bell pepper*), Cucumis sativus (*cucumber*), Cucurbita moschata (*pumpkin*), Cynodon dactylon (*Bahama grass*), Datura, Daucus carota (*carrot*), Digitaria, Dioscorea (*yam*), Dioscorea alata (*white yam*), Elaeis guineensis (*African oil palm*), Ficus elastica (*rubber plant*), Fragaria ananassa (*strawberry*), Helianthus annuus (*sunflower*), Hibiscus (*rosemallows*), Lactuca sativa (*lettuce*), Lablab purpureus (*hyachinth bean*), Lolium (*ryegrass*), Lycopersicon esculentum (*tomato*), Manihot esculenta (*cassava*), Mimosa pudica (*action plant*), Mangifera indica (*mango*), Musa (*banana*), Nicotiana tabacum (*tobacco*), Olea europaea subsp. europaea (*olive*), Oryza sativa (*rice*), Pandanus, Panicum maximum (*buffalo grass*), Paspalum conjugatum (*buffalo grass*), Paspalum notatum (*bahiagrass*), Phaseolus vulgaris (*common bean*), Piper nigrum (*black pepper*), Pinus caribaea (*Caribbean pine*), Rosa (*roses*), Rosa multiflora (*Multiflora rose*), Saccharum officinarum (*sugarcane*), Schefflera, Solanum melongena (*aubergine*), Theobroma cacao (*cocoa*), Zea mays (*maize*), Zingiber officinale (*ginger*),Coffea (*coffee*), Hevea brasiliensis (*rubber*),* (Crop Protection Compendium – CAB International 2002 Edition)
Control	1. Nematicide : i) Oxamyl ii) Fensulphothion iii) Ethoprophos iv) Aldicarb v) Carbofuran (A.G. Whitehead (1998) Plant Nematode Control. *CAB International)*
References	1. A.G. Whitehead (1998) Plant Nematode Control. *CAB International, 132-139* 2. Annual Report 1999. Crop Protection and Plant Quarantine. 3. Crop Protection Compendium – CAB International 2002 Edition

6.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species Name	*Criconemella xenoplax* De Grisse & Loof, 1965
Common Name	ring nematode
Phyllum	Nematoda
Class	Secernentea
Order	Tylenchida
Family	Criconematidae
Synonym	Criconemoides Taylor, 1936 Crossonemoides Eroshenko, 1981 Macroposthonia de Man, 1880 Madinema Khan, Chawla & Saha, 1976 Mesocriconema Andrassy, 1965 Neobakernema Ebsary, 1981 Seshadriella Darekar & Khan, 1981 Xenocriconemoides De Grisse & Loof, 1965 (Crop Protection Compendium – CAB International 2002 Edition)
Distribution	[Malaysia] Peninsular Malaysia: present, (Crop Protection Compendium – CAB International 2002 Edition)
Status	Minor
Biology & Ecology	Ring nematode (*Criconemella xenoplax*) is migratory ectoparasites. The female *C. xenoplax* life cycle took 25-35 days (Seshadri, 1964) and the female survived for over 2 months. After feeding for several days on roots, females deposit single eggs every two to four days (Thomas, 1959). Four moults occurred, the first of which was inside the egg, and feeding was necessary before all juvenile stages could continue development. Second stage juveniles (J2) hatch from the egg in 11-15 days, molt to J3 in 3-5 days which then molt to J4 in 4-7 days to become adults 5-6 days later. Males are almost never observed. Feeding was on root tips or anywhere along the root. Ring nematodes increase more in coarse than in fine textured soils. Optimum conditions for reproduction include a pH near 7 and soil temperatures between 75 and 80^{o} F. Ring nematodes appear to be sensitive to low soil moisture and low pH. Populations decline rapidly in the presence of a poor host. Roots systems are reduced and top growth is stunted. **Affected Plant Stages:** Flowering stage, fruiting stage, seedling stage, and vegetative growing stage. ***Affected Plant Parts:*** Whole plant, roots, and fruits/pods. **Symptom:** No information.

Host	**Primary hosts:** *Ananas comosus* (pineapple), *Arachis hypogaea* (groundnut), *Brassica*, *Citrus* sp. (Citrus), *Cinnamomum* (cinnamon), Coffea (coffee), *Dianthus caryophyllus* (carnation), *Ipomoea batatas* (sweet potato), *Mangifera indica* (mango), *Musa* (banana), *Nicotiana tabacum* (tobacco), Oryza sativa (rice), *Prunus dulcis* (almond), *Psidium guajava* (common guava), *Rosa (*roses), *Saccharum officinarum* (sugarcane), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Sorghum*, *Theobroma cacao* (cocoa), *Zea mays* (maize). Crop Protection Compendium – CAB International 2002 Edition
Control	1. Nematicide : i) Fenamiphos (A.G. Whitehead (1998) Plant Nematode Control. *CAB International)*
References	*1.* A.G. Whitehead (1998) Plant Nematode Control. *CAB International, 132-139* 2. Annual Report 1999. Crop Protection and Plant Quarantine 3. Crop Protection Compendium – CAB International 2002 Edition 4. http://ucdnema.ucdavis.edu/imagemap/nemmap/ENT156HTML/E156phylo

7.0 PESTS(NEMATODE) FACT SHEET ANTHURIUM

Species Name	*Pratylenchus brachyurus* (Godfrey, 1929) Filipjev & Schuurmans Stekhoven, 1941
Common Name	meadow nematode root-lesion nematode smooth headed nematode
Phyllum	Nematoda
Class	Secernentea
Order	Tylenchida
Family	Pratylenchidae
Synonym	*Anguillulina (Pratylenchus) brachyura* (Godfrey, 1929) Goodey, 1932 (W. Schneider, 1939) *Anguillulina brachyura* (Godfrey, 1929), Goodey, 1932 *Pratylenchus leiocephalus* Steiner, 1949 *Pratylenchus pratensis* Thorne, 1949 *Pratylenchus steineri* Lordello, Zamith & Boock, 1954 *Tylenchus (Chitinotylenchus) brachyurus* Godfrey, 1929 (Filipjev, 1934) *Tylenchus brachyurus* Godfrey, 1929 (Crop Protection Compendium – CAB International 2002 Edition)
Distribution	[Malaysia] Peninsular Malaysia: present. Sabah: present. Sarawak: present (Crop Protection Compendium – CAB International 2002 Edition)
Status	Minor
Biology & Ecology	Reproduction was more rapid at higher temperatures (26.7-32.2°C) (Graham, 1965). Boswell (1968) reported 26°C as the optimum temperature for reproduction. The rate of development and the life cycle depends on the host plant and the environmental conditions, especially soil temperature (Boswell, 1968). Optimum temperature for egg production is 35°C. Eggs are laid singly in the root tissues and in the soil and the larvae undergo four moults. The first moult occurs inside the egg (Roman and Hirschman, 1969). The period to complete one generation varies with host, and depends to a large extent on the temperature. *P. brachyurus* can survive for several months without a host plant. It can survive long periods in dry soil as well as exposure to extremes in temperature (McGowan, 1978). **Affected Plant Stages:** Pre-emergence, seedling stage, vegetative growing stage, flowering stage, and fruiting stage. **Affected Plant Parts:** Leaves, roots, seeds, stems, and whole plant. **Symptoms** Leaves: abnormal colours; wilting. Roots: reduced root system; necrotic streaks or lesions; cortex with lesions. Seeds: lesions on seeds. Stems: stunting or rosetting. Whole plant: plant dead; dieback; dwarfing. (Crop Protection Compendium – CAB International 2002 Edition)

Host	**Primary hosts:** *Ananas comosus* (pineapple), *Anthurium* sp. (Anthurium*), Arachis hypogaea* (groundnut), *Camellia sinensis* (tea), *Cajanus cajan* (pigeon pea), *Chrysanthemum coronarium*, *Citrus, Coffea* (coffee), *Cymbopogon citratus* (lemongrass), *Dioscorea* (yam), *Glycine max* (soyabean), Gossypium (cotton), *Hevea brasiliensis* (rubber), *Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Persea americana* (avocado), *Prunus persica* (peach), *Rosa multiflora* (Multiflora rose), *Saccharum officinarum* (sugarcane), *Solanum tuberosum* (potato), *Theobroma cacao* (cocoa), *Zea mays* (maize). **Secondary hosts:** *Allium cepa* (onion), *Avena sativa* (oats), Citrullus, *Cucumis sativus* (cucumber), Cucurbita, *Helianthus annuus* (sunflower), *Hibiscus cannabinus* (kenaf), *Hordeum vulgare* (barley), *Impatiens* (balsam), *Ipomoea batatas* (sweet potato),*Lycopersicon esculentum* (tomato), *Manihot esculenta* (cassava), *Mangifera indica* (mango), *Solanum melongena* (aubergine), Sorghum, *Sorghum sudanense* (Sudan grass), *Triticum aestivum* (wheat), Vanilla, *Vigna unguiculata* (cowpea),*Zingiber officinale* (ginger). Crop Protection Compendium – CAB International 2002 Edition
Control	1. Nematicide : i) Fenamiphos ii) Fensulphothion iii) Carbofuran (A.G. Whitehead, 1998, Plant Nematode Control)
References	1. A.G. Whitehead (1998) Plant Nematode Control. *CAB International, 117-118.* 2. Annual Report 1999. Crop Protection and Plant Qurantine. 3. Crop Protection Compendium – CAB International 2002 Edition 4. http://ucdnema.ucdavis.edu/imagemap/nemmap/ENT156HTML/E156phylo