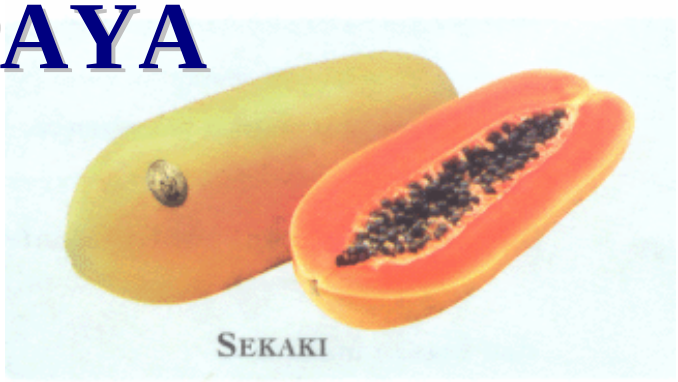
TECHNICAL DOCUMENT FOR MARKET ACCESS ON PAPAYA



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

AGRONOMIC ASPECTS

Name Of Crop : Papaya
Botanical Name : *Carica Papaya Linn*
Family : Caricaceae
Local name : Betik

INTRODUCTION

The papaya is believed to be a native to Tropical America where it is known as pawpaw. Papaya in Malaysia was often regarded as smallholder crop and because of its short gestation period, bearing within 9 months and with an economic l crop cyle of 3 years, it was popular as a cash crop during early establishment of rubber and oil palm plantation. However this scenario changed with the advent of Eksotika papaya in 1987, which started the establishment of permanent farms and stable export market. The total hectarage planted in Peninsular Malaysia is about 2,300 ha with production of about 84.64 metric tonne (year 2000). The main commercial planting areas are in Perak with a total hectarage of 1,028 ha. Followed by Johor with 331 ha.

Malaysia exported about 51,631 metric tonnes of papaya in year 2000 with a toal value of RM69 million and mainly to Singapore, Hong Kong, Europe and Middle East.

Most of the papaya fruits are for fresh consumption and only a negligible portion of it goes into processing.

Nutrient Composition of papaya ia as follows:

Nutrient	*Composition /100 gm edible portion
Energy	59.0 KCal
Moisture	84.4%
Protein	1.0 gm
Fat	0.1 gm
Carbohydrate	13.5 gm
Fibre / Ash	0.5 gm / 0.5 gm
Calsium / magnesium	31.0 mg / 0.8 mg
Phosphorous	17.0 mg
Iron / Sodium	1.0 mg / 2.0 mg
Potassium	337.0 mg
Vit B1 & B2	0.23 mg
Niacin	0.1 mg
Ascorbic Acid (Vit C)	69.3 mg
Carotene	2431 ug
R.E	405 ug

CROP REQUIREMENT

Papaya being a non seasonal plant, has the potential of producing fruits throughout most months of the year under good management**.**

Climate

Papaya perform well in regions with even rainfall without dry spell as drought will induce floral abortion. It requires an annual rainfall of 1200 mm with temperature between 21 - 33°C. Papaya should not be planted in areas with strong wind, since being shallow rooted plants are easily lodged.

Soil

Papaya requires a soil with good drainage. It does not tolerate flooding, so a deep well drained and good structured soil is preferable. A soil pH of 5.0 - 5.5 is necessary.

VARIETIES/CLONES

The most popular varieties that are widely grown are Eksotica, Eksotica ll, and Foot long (betik sekaki). The characteristics of the various varieties are as per table below:

Eksotica	Eksotica ll	Foot Long
Tree		
Developed from a backcross between Hawaiian sunrise solo and Subang 6. Plant of medium height and start flowering 4 months after planting	Hybrid variety developed a cross between line 19 and line 20 exotica. Plant of medium height but show better vigour and taller than Eksotika. Start flowering 4 months after planting. Higher yield compared to eksotica	Plant starts flowering 3-4 months after planting.
Fruit		
Fruit harvested after 9 months of planting each fruit weighs about 600-900 gm. Freckles on the skin	Harvested at 9 months after planting Each fruit weights about 600-1000 gm. Less freckles on the skin	Smooth skin and free from freckles when ripens, skin turns from green to yellow; each fruit weighs about 1.5 - 2.4 kg.

Flesh		
Orange-red in colour. High sugar content (brix 13-15%).	Orange-red in colour, firm flesh, sweeter than exotica (brix 14.5%)	Orange-red in colour, firm flesh, sweet brix 11-12%

Eksotica variety
(Source: Department of Agriculture Malaysia)

Eksotica variety
(Source: Department of Agriculture Malaysia)

Eksotica variety
(Source: Department of Agriculture Malaysia)

Foot Long variety
(Source: Department of Agriculture, Malaysia)

CULTURAL PRACTICES

Planting Materials

Seed is the most common planting materials used for propagation of papaya. It is important to maintain the purity of Eksotika during seed production so that the desirable qualities of the fruit are not lost. Another method of propagation i.e clonal propagation using grafting results in more uniform populations compared with seed propagation. It totally eliminates the presence of female trees in the orchard.

Planting System

Rectangular system is recommended for planting. The recommended planting distance is 2.7m x 1.8m giving a total of 2000 plants/ha. Planting holes of 0.3m x 0.3m x 0.3m in size are dug and allowed to weather for 2-4 weeks. Organic matter or compost at 1-2 kg/hole and 200 gm/hole of TSP (Triple super phosphate) are incorporated into the hole and seedling is planted with minimal disturbance to the roots.

Fertilization

The recommended fertilization programme is as follows:

Age of trees (months)	Compound fertiliser (N:P:K:Mg)	No. of application/ year	Amount of fertiliser plant/year (kg)
1	15:15:15	3-4	0.05
2	15:15:15	3-4	0.05
3	15:15:15	3-4	0.10
5	12:12:17:2	3-4	0.35
>5	12:12:17:2	6	0.35
Setiap 6 bulan	Organan	2	2.0

Borax fertiliser (1-5 gm/plant) should be added if boron deficiency symptom appears.

Water Management

Papaya should be irrigated to encourage development and healthy growth of plants especially during the early stage of growth. Lack of moisture causes abortion of floral and fruit structures leading to sterile phases

MATURITY AND HARVEST

Maturity

The trees are expected to flower 3 –4 months after transplanting and the fruit will mature about 5 months later. This means that maturation age of papaya is about 8 – 9 months..

Harvesting Indices

The optimum stage of maturity is between 17 - 20 weeks after flower anthesis. Harvesting at the proper stage of maturity is very essential to ensure the quality.

The ripening of papaya is divided into 6 stages of skin colour as follows:

Colour index 1 :	Full green
Colour index 2 :	Green with trace of yellow
Colour index 3 :	More green than yellow
Colour index 4 :	More yellow than green
Colour index 5 :	Yellow with trace of green
Colour index 6 :	Fully yellow

Normally fruits are harvested at colour index 2 and 3 for further handling. Studies have shown that fruits at colour index 1, 2 and 3 are free from fruit flies attack and anthracnose infestation. Fruits of colour index 1 are not suitable for table consumption because they do not give a good ripened fruit as those harvested at colour indices 2 and 3. It is recommended that fruits for export should be harvested at colour index 2 or 3 only depending on the destinations and are not allowed falling on the ground to avoid risk of contamination by pathogens. Subsequently, fruits harvested at colour index 4 and 5 are not suitable for transportation.

Yields

Economic life of papaya is about 2-3 years. Maximum production is on the 13-14 th month after planting. Papaya eksotica will give a yield of about 40-65 ton/ha /year, eksotica ll about 50-80 ton/ha/year and Foot long variety yield about 100-150 ton/ha/year

Seasonality

Papaya being a non seasonal plant, has the potential of producing fruits throughout most months of the year under good management**.**

Harvesting

The first fruits are borne about 3 to 4 feet from the ground, so the harvesting in the first year can be conveniently done by hand. In the second year, the harvesting process becomes more tedious because the trees will bear fruits beyond the reach of the harvester. In such circumstances, a long stick with a small wire basket lined with sponge attached to the end will facilitate the harvester

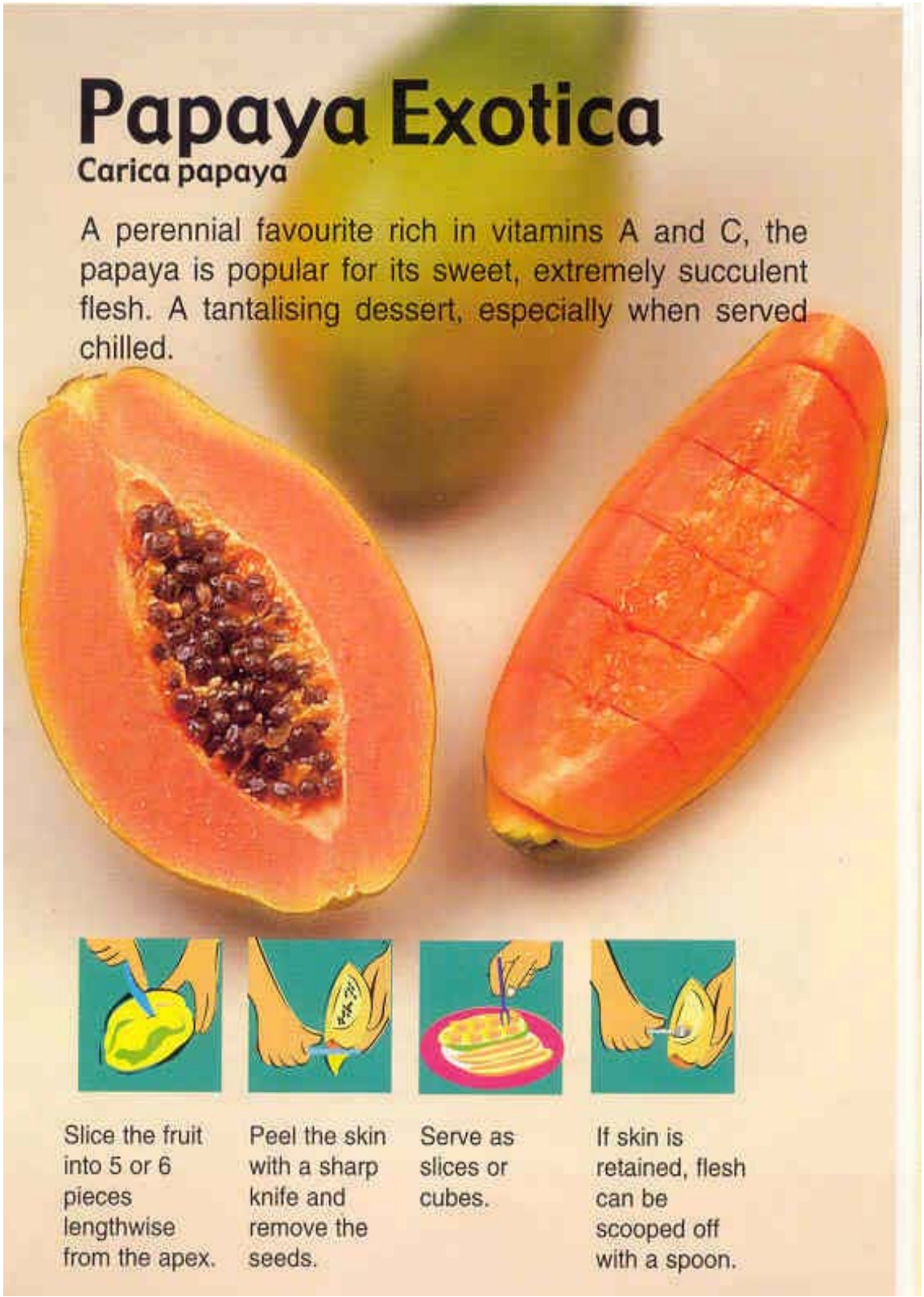
HANDLING AND STORAGE

Post harvests handling of papaya include sorting, washing, hot water and fungicidal treatment, drying and grading. The graded fruits are then packed into plastic containers or bamboo baskets padded with newspapers or banana leaves for local market. For export fruits are packed in corrugated fibreboard boxes.

Storage

Fruit of colour indices 2and 3 can be stored at ambient temperature (25 – 30 C) for about 5-7 days while fruit at colour indices 4 and 5 can only last for 2 – 3 days. For longer storage fruits should be stored at 10 – 12 C. At this temperature they can be stored for 2 weeks and the time is sufficient to air freight the fruits around the world. With modified atmosphere packaging (MAP), the storage period can be extended to 3 weeks and suitable for sea shipment to Hong Kong and Middle East

FRESH AND DELICIOUS



Discovering Malaysian fruits
(Source: Federal Agricultural Marketing Authority (FAMA), Ministry of Agriculture Malaysia)

FRESH AND DELICIOUS

Discovering Malaysian fruits
(Source: Federal Agricultural Marketing Authority (FAMA), Ministry of Agriculture Malaysia)

PESTS(INSECT) LIST OF PAPAYA

PESTS(INSECT) LIST OF PAPAYA IN MALAYSIA

	Genus	Species	Order	Family	Common Name	Parts Affected	Verification Method	Distribution	Status Ahmad Yunus (1980)	Status Upto 2003
1	*Aonidiella*	*orientalis*	Hemiptera	Diaspididae	Oriental scale	Leaf, stem, fruit	C2,L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
2	*Aphiochaeta*	*scalaris*	Diptera	Phoridae	_	Fruit	C2,L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
3	*Araecerus*	*fasciculatus*	Coleoptera	Anthribidae	Areca nut weevil	Stem	C2,L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
4	*Bactrocera*	*papayae*	Diptera	Tephritidae	Papaya fruit fly	Fruit	C2,L1	PM, Sa	P(5)(Ahmad&Ho,1980)	A(1)
5	*Haptonous*	*sp*	Coleoptera	Nitidulidae	_	Fruit	L1	PM	P(5)(Ahmad&Ho,1980)	A(1)
6	*Litargus*	*sp*	Coleoptera	Mycetophagidae	_	Stem	L1	PM	P(5)(Ahmad&Ho,1980)	A(1)
7	*Nasutitermes*	*havilandi*	Isoptera	Termitidae	_	Stem	L1	PM	P(5)(Ahmad&Ho,1980)	A(1)
8	*Pinnaspis*	*sp.*	Hemiptera	Diaspididae	_	Leaf	C2,L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
9	*Ptilocera*	*quadridentata*	Diptera	Stratiomycidae	_	Stem	L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
10	*Schedorhinotermes*	*javanicus*	Isoptera	Rhinotermitidae	_	Stem	L1	PM	P(5)(Ahmad&Ho,1980)	A(1)
11	*Spodoptera*	*litura*	Lepidoptera	Noctuidae	Armyworm	Leaf	C2,L1	PM, Sa, Swk	P(5)(Ahmad&Ho,1980)	A(1)
12	*Termes*	*malaccensis*	Isoptera	Termitidae	_	Stem	L1	PM	P(5)(Ahmad&Ho,1980)	P(5)(DOA 2002)
13	*Xyleborus*	*semigranosus*	Coleoptera	Scoltidae	_	Stem	C2,L1	PM, Sa, Swk	P(5)(Ahmad&Ho,1980)	A(1)

REFERENCE:

1 Anon (1999) Jabatan Pertanian. Pakej Teknologi Papaya JP/Bk 02.09/11-99/1.2R
2 Crop Protection Compendium. (2002). CAB International
3 K.G.Singh (1980), A Check List of Host And Disease In Malaysia. Ministry of Agriculture.

CODE	
PM	Peninsular Malaysia
Swk	Sarawak
Sa	Sabah

VERIFICATION CODE	
C1	Collection centre
C2	Compendium
L1	Literature/ Jurnal /Publication
P1	Personel 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 records unreliable
A(5)	Absent : intercepted only
P(1)	Present : in all parts of the area
P(2)	Present : only in some areas
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

PESTS (INSECT) FACT SHEET OF PAPAYA

1.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Aonidiella orientalis* (Newstead, 1894)
Common Name	Oriental red scale Oriental yellow scale Scale, oriental Scale, oriental red Scale, red Oriental scale Scale, oriental yellow
Phyllum	Arthroptora
Class	Insecta
Order	Hemiptera
Family	Diaspididae
Synonym	*Aonidiella cocotiphagus* (Marlatt) Ferns, 1938 *Aonidiella taprobana* (Green) MacGillivray, 1921 *Aspidiotus cocotiphagus* Matlatt, 1908 *Aspidiotus orientalis* Newstead, 1894 *Aspidiotus osbeckiae* Green, 1896 *Aspidiotus pedronis* Green, 1905 *Aspidiotus taprobanus* Green. 1905 *Chrysomphalus orientalis* (Newstead) Lindinger, 1913 *Chrysomphalus pedroniformis* Cockerell & Robinson, 1915 *Chrysomphalus pedronis* (Green) Sanders,1906 *Evaspidiotus orientalis* (Newstead) Leonardi, 1898 *Furcaspis orientalis* (Newstead) MacGillivray, 1921
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	Morphology The adult female scale cover is circular and flat in shape, almost white to pale brown or yellow, with yellow to dark brown exuviae positioned more or less centrally. Adult female insect with prosoma pyriform, expanding to subcircular and becoming moderately sclerotized around margins at maturity. Pygidium quite well sclerotized dorsally. Median lobes distinctly larger than second lobes, with fourth lobes represented by small points on either side. Plates lateral to third lobes not fringed, each with a long fleshy process present at mesal angle. Abdominal segments 1 to 3 with a submarginal row or cluster of dorsal macroducts present on each side. Thoracic tubercles are minute. Perivulvar pores present in 4 or 5 groups, ranging from 19 to 32 in number. Prevulvar scleroses and apophyses absent. Adult females measure 1.0-1.4 mm in length when slide-mounted (William and Watson, 1988) Male scales are elongate to oval in shape and similar to females, but smaller, with yellow exuviae near one end (Williams and Watson, 1988) Life cycle The eggs are laid under the female scale cover. The larvae (first instar

	crawlers) emerge from under the female, and crawl for several hours until they find suitable host plant tissue into which to insert their stylets. The females subsequently remain immobile, with successive moults adding to the size of the scale. Females have two moults before attaining maturity. The males have additional prepupal and pupal moults before attaining a winged adult stage. Adult males lack mouthparts, do not feed and are relatively short-lived. Mating and the laying of eggs is the most important route by which crawlers are produced (Rajagopal and Krishnamoorthy, 1996). In laboratory studies, males took an average of 19.5 days to proceed from the crawler stage to adult and females took an average of 44.2 days from the crawler stage to production of the first crawler of the subsequent generation (Elder and Smith, 1995). Crawlers and female scales feed on dilute sap and surplus carbohydrate and nitrogen is converted into material to construct the scale cover, and not into honeydew as in other scale insect families (Anon., 2002) **Affected Plant Stages** Seedling stage, vegetative growing stage, flowering stage, and fruiting stage. **Affected Plant Part** Leaf, stem and fruit. **Symptom and Damage** Direct feeding damage on leaves and removal of plant sap reduces plant vigour. Feeding often causes depressions, discoloration and distortion of leaves. Heavy infestations can result in the yellowing of foliage and defoliation, dieback of small twigs and premature fruit drop (Rajagopal and Krishnamoorthy, 1996). Cosmetic damage may also occasionally occur to fruits. Descriptors: Leaves: abnormal colours; abnormal forms; abnormal leaf fall; yellowed or dead; external feeding. Stems: dieback; external feeding; distortion. Fruits/pods: external feeding; discoloration.
Host	A. orientalis is highly polyphagous. It can attack almost any host except conifers. It can be an economic pest of crops from diverse families. These include: species of Citrus and Ficus, mango, papaya, bananas and other fruits; palm trees, including coconut and arecanut (Areca catechu); and tea (Anon., 2002).
Control	**Chemical Control** The usual chemical treatment is mineral oil sprays, although these are not routinely recommended as they interfere with the natural biological control of pest insects in orchards and plantations. Malathion, dimethoate and diazinon have been recommended for dealing with severe infestations.

References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Anonymous (2002). Crop Protection Compendium. CAB International. 3. Elder RJ, Smith D, 1995. Mass rearing of Aonidiella orientalis (Newstead) (Hemiptera:Diaspididae) on butternut gramma. Journal of the Australian Entomological Society, 34(3):253-254. 4. Rajagopal D, Krishnamoorthy A, 1996. Bionomics and management of oriental yellow scale, Aonidiella orientalis (Newstead) (Homoptera:Diaspididae): an overview. Agricultural Reviews Karnal, 17(3/4):139-146. 5. Williams, D. J. and Watson, G. W. (1988). The Scale Insects of the Tropical South Pacific Region Part 1 The armoured Scales (Diaspididae). C.A.B International.42pp.

2.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Aphiochaeta scalaris* (Lowe)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Diptera
Family	Phoridae
Synonym	*Megaselia scalaris* (Loew)
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	A. scalaris is a small fly (length 2-3 mm) with known scavenging properties. Larvae of the fly have been implicated in intestinal, urogenital, corneal and wound mysias. Infestation of fruits, including bananas, with fly larvae is a known occurrence. **Affected Plant Stages** No information **Affected Plant Part** Fruit **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Anonymous (2002) crop Protection Compendium. CAB International 3. http://www.slmaonline.org/cmj/CMJ4701/9.htm

3.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Araecerus fasciculatus* (De Geer)
Common Name	Areca nut weevil Cocoa weevil Coffee bean weevil Coffee weevil Nutmeg weevil
Phyllum	Arthroptora
Class	Insecta
Order	Coleoptera
Family	Anthribidae
Synonym	*Amblycerus japonicus* Thunberg *Anthribus coffeae* Fabriciuis *Araecerus coffeae* (Fabricius) *Curculio fasciculatus* De Geer
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	**Morphology** Adults A. fasciculatus adults are 3-5 mm long with a mottled, dark-brown appearance, particularly on the elytra. Adults have capitate antennae with the last three distal segments enlarged. Their elytra have punctate indentations and are covered with bristles. Legs have five-segmented tarsi with the third and fourth segments relatively inapparent. The combined length of all tarsal segments equal or exceed the length of the tibia. The males have the aedeogus characteristic, with a pair of triangular sclerites in the inner sac (Morimoto, 1978). Eggs The eggs are approximately 0.6 mm long, ovoid and pale in appearance. The surface of the egg is covered with a random pattern of pits (Anon., 2002) Larvae A. fasciculatus usually have four instars but occasionally may have three or five. The larvae have curved bodies with an enlarged thoracic region. They are whitish and grow up to 5-6 mm long. Larvae have no legs but they have pedal lobes on the thorax. Larvae have ten abdominal segments with the last tucked into the preceding segment. The body is covered with fine hairs (Lee and Morimoto, 1987).

	Pupae Pupae are exarate in form. They begin white and darken as they mature. The final larval cuticle remains stuck to the last three abdominal segments and cannot be removed without harming the pupa (Anon., 2002). **Biology and ecology** Adult *A. fasciculatus* feed externally on commodities and may live up to 17 weeks at optimal humidity (80%+ RH). At lower humidities, adult life span may be considerably shorter, especially on cocoa beans. Each female lays approximately 50 eggs on or near the commodity. Incubation time of the egg is from 5-9 days at optimal humidity (Anon., 2002). Newly-hatched larvae bore into the commodity and develop internally. Larval development time varies considerably depending upon commodity type, the moisture content of the commodity and relative humidity. On maize, larval development time at optimal conditions (27°C, 100% RH) was 29 days but increased to 56 days when humidity was lowered to 60%. In general, larvae cannot survive relative humidities below 60%. The moisture content of the commodity also affects larval development and survival. A. fasciculatus females preferentially attack cocoa beans at moisture contents between 17 and 20%, but will attack beans with a moisture content as low as 12%. In contrast, A. fasciculatus will significantly attack coffee beans at moisture contents over 12-13% but larvae cannot survive on beans with a moisture content below 8%. Generally, larval development time in favourable field conditions will range from 46-66 days (Anon., 2002) Larvae pupate in the commodity. The combined prepupal and pupal stages last up to 8 days depending upon humidity. Upon eclosing, adults chew their way out of the commodity. Little research has been done on flight and dispersal of *A. fasciculatus*; but the primary means of dispersal is probably through transportation and distribution of infested commodities (Anon., 2002) **Affected Plant Stages** Flowering stage, fruiting stage and post-harvest. **Affected Plant Part** Stems **Symptom and Damage** No information.
Host	A. fasciculatus is primarily a pest of stored commodities, although it may attack coffee berries while still on the plant. A. fasciculatus has a

	wide host range. Its ability to attack a broad spectrum of commodities is improved by high moisture content of the food or high relative humidity of the environment. A. fasciculatus is of primary importance on coffee beans, cocoa, and cassava. Properly stored coffee beans and cocoa suffer much less damage than badly stored commodities, but A. fasciculatus acts as a contaminant even in a properly stored commodity. A. fasciculatus can do severe damage to stored cassava. Reports of A. fasciculatus attacking sugarcane are not uncommon, but their presence on the plant may be due to feeding on a smut of sugarcane (Anon., 2002). **Primary hosts:** Allium sativum (garlic), Arachis hypogaea (groundnut), Cocos nucifera (coconut), Citrus, Citrus sinensis (navel orange), Coffea (coffee), Dioscorea (yam), Elaeis guineensis (African oil palm), Helianthus annuus (sunflower), Ipomoea batatas (sweet potato), Manihot esculenta (cassava), Macadamia, Musa (banana), Myristica fragrans (nutmeg), Persea americana (avocado), Phaseolus (beans), Saccharum officinarum (sugarcane), Solanum tuberosum (potato), Sorghum, stored products (dried stored products), Theobroma cacao (cocoa), wheat flour, Zea mays (maize).
Control	No information on papaya.
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Anonymous (2002). Crop Protection Compendium. CAB International. 3. Lee CY, Morimoto K, 1987. Larvae of the weevil family Anthribidae of Japan (Coleoptera). Journal of the Faculty of Agriculture, Kyushu University, 31(1-2):71-86. 4. Morimoto K, 1978. The family Anthribidae of Japan (Coleoptera). Part 1. Esakia, 12:17-47.

4.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Bactrocera papayae*
Common Name	Papaya fruit fly
Phyllum	Arthroptora
Class	Insecta
Order	Diptera
Family	Tephritidae
Synonym	
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	**MORPHOLOGY** Egg Size, 0.8 mm long, 0.2 mm wide, with the micropyle protruding slightly at the anterior end (Margaritis, 1985). Larvae B. papayae third instar larva: larvae medium-sized, length 7.0-9.0 mm; width 1.5-1.8 mm. Head: sStomal sensory organ large, rounded and protuberant; with 3-4 sensilla (1 short and peg-like, 2-3 long and tapered), surrounded by 5-6 large preoral lobes, some with obviously serrated edges; oral ridges with 10-15 rows of short, gently tapered, bluntly rounded teeth; 15-19 small irregular-shaped accessory plates with small serrations along posterior margins; mouthhooks moderately sclerotized, without preapical teeth. Thoracic and abdominal segments: broad bands of long, sharply pointed spinules in discontinuous rows surrounding anterior margins of thoracic segments. T1 with 7-10 rows dorsally and laterally, increasing to 11-15 rows ventrally; T2 with 4-8 rows dorsally and laterally, and 7-9 rows ventrally; T3 with 3-5 rows dorsally and 3-4 rows laterally (sometimes absent in midline), and 3-6 rows ventrally. Dorsal spinules absent from A1-A8. Creeping welts with long, stout, sharply pointed spinules, with several rows of spinules posteriorly directed. A8 with large intermediate areas and obvious dorsal and lateral sensilla. Anterior spiracles: 11-15 tubules. Posterior spiracles: spiracular slits about 3 times as long as broad, with heavily sclerotized rimae. Spiracular hairs very distinct with broad trunks, branched in apical half; dorsal and ventral bundles of 15-25 hairs, lateral bundles of 6-10 hairs. Anal area: lobes large, protuberant, surrounded by 3-6 rows of very long, sharply pointed spinules forming discontinuous rows dorsally and laterally, and becoming a small concentration of individual spinules below anal opening (White and Elson-Harris, 1994).

	Pupa Barrel-shaped with most larval features unrecognisable, the exception being the anterior and posterior spiracles which are little changed by pupariation. White to yellow-brown in colour. Usually about 60-80% length of larva (Anon., 2002). Adults Bactrocera (Bactrocera) spp. with a clear wing membrane, except for a narrow costal band (not reaching R4+5); cells bc and c colourless (except in a few non-pests with a very pale tint) and devoid of microtrichia. Scutum mostly black; with lateral but not medial vittae; yellow scutellum, except for basal band which is usually very narrow; abdomen with a medial dark stripe on T3-T5; dark laterally (but form of marking varies from species to species). B. dorsalis belongs to a subgroup which have yellow postpronotal lobes, parallel lateral vittae, and femora not extensively marked. Within this group it is distinguished by its short aculeus/aedeagus; tomentum with no gap; narrow costal band; narrow abdominal markings (Drew and Hancock, 1994). **BIOLOGY AND ECOLOGY** No specific details on the biology of B. papayae are available. Eggs of related species are laid below the skin of the host fruit. These hatch within a day (although delayed up to 20 days in cool conditions) and the larvae feed for another 6-35 days, depending on season. Pupariation is in the soil under the host plant for 10-12 days but may be delayed for up to 90 days under cool conditions. Adults occur throughout the year and begin mating after about 8-12 days, and may live 1-3 months depending on temperature (up to 12 months in cool conditions) (Christenson and Foote, 1960). Adult flight and the transport of infected fruit are the major means of movement and dispersal to previously uninfested areas. Many Bactrocera spp. can fly 50-100 km (Fletcher, 1989). **Affected Plant Stages** Fruiting stage and post-harvest. **Affected Plant Part** Fruits **Symptom and Damage** Following oviposition there may be some necrosis around the puncture mark ('sting'). This is followed by decomposition of the fruit. Descriptors: Fruits/pods: internal feeding; lesions: black or brown; premature drop.

Host	**Primary hosts:** Artocarpus integer (jack tree), Anacardium occidentale (cashew nut), Averrhoa bilimbi, Citrus aurantiifolia (lime), Citrus maxima (pummelo), Citrus limon (lemon), Coffea arabica (arabica coffee), Coffea canephora (robusta coffee), Cucumis sativus (cucumber), Flacourtia rukam (rukam), Fortunella japonica (round kumquat), Fortunella margarita (oval kumquat), Garcinia mangostana (mangosteen), Lycopersicon esculentum (tomato), Mangifera foetida (bachang), Mangifera odorata, Persea americana (avocado), Phaseolus vulgaris (common bean), Rhizophora, Solanum melongena (aubergine), Theobroma cacao (cocoa), Carica papaya (papaw), Mangifera indica (mango), Musa paradisiaca (plantain).
Control	**Cultural Control and Sanitary Methods** One of the most effective control techniques against fruit flies in general is to wrap fruit, either in newspaper, a paper bag, or in the case of long/thin fruits, a polythene sleeve. This is a simple physical barrier to oviposition but it has to be applied well before the fruit is attacked. There is also some evidence that neem seed kernel extract can deter oviposition. Little information is available on the attack time for most fruits but few Bactrocera spp. attack prior to ripening (Anon., 2002). **Chemical Control** Although cover sprays of entire crops are sometimes used, the use of bait sprays is both more economical and more environmentally acceptable. A bait spray consists of a suitable insecticide (e.g. malathion) mixed with a protein bait. Both males and females of fruit flies are attracted to protein sources emanating ammonia, and so insecticides can be applied to just a few spots in an orchard and the flies will be attracted to these spots. The protein most widely used is hydrolysed protein, but some supplies of this are acid hydrolysed and so highly phytotoxic. Smith and Nannan (1988) have developed a system using autolysed protein. In Malaysia this has been developed into a very effective commercial product derived from brewery waste (Anon., 2002) **Male Suppression** The males B. dorsalis are attracted to methyl eugenol (4-allyl-1,2-dimethoxybenzene), sometimes in very large numbers. On a small scale many farmers use male suppression as a control technique; however, with flies attracted over a few hundred metres the traps may be responsible for increasing the fly level (at least of males) on a crop as much as for reducing it. However, the technique has been used as an eradication technique (male annihilation), in combination with bait (Bateman, 1982).
References	1. Ahmad Y. and Ho T. H. (1979). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

2. Anonymous (2002). Crop Protection Compendium. CAB International.

3. Bateman MA, 1982. III. Chemical methods for suppression or eradication of fruit fly populations, In: Drew RAI, Hooper GHS, Bateman MA (eds). Economic Fruit Flies of the South Pacific Region. 2nd edition. Brisbane, Australia: Queensland Department of Primary Industries, 115-128.
4. Christenson LD, Foote RH, 1960. Biology of fruit flies. Annual Review of Entomology, 5:171-192.

5. Drew RAI, Hancock DL, 1994. The Bactrocera dorsalis complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia. Bulletin of Entomological Research, 84(2(SUP)):68 pp.; 33 ref.

6. Fletcher BS, 1989. Ecology; life history strategies of tephritid fruit flies, In: Robinson AS, Hooper G, eds. Fruit Flies; their Biology, Natural Enemies and Control. World Crop Pests. Amsterdam, Holland: Elsevier, 3(B):195-208.

7. Margaritis LH, 1985. Comparative study of the eggshell of the fruit flies Dacus oleae and Ceratitis capitata (Diptera: Trypetidae). Canadian Journal of Zoology, 63(9):2194-2206; [13 fig.]; 22 ref.

8. Smith D, Nannan L, 1988. Yeast autolysate bait sprays for control of Queensland fruit fly on passionfruit in Queensland. Queensland Journal of Agricultural and Animal Sciences, 45(2):169-177; 14 ref.

9. White IM, Elson-Harris MM, 1994. Fruit Flies of Economic Significance; Their Identification and Bionomics. Wallingford, UK: CAB International.

5.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Haptonous sp*
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Coleoptera
Family	Nitidulidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	No information **Affected Plant Stages** No information **Affected Plant Part** Fruit **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

6.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Litargus sp*
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Coleoptera
Family	Mycetophagidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	No information **Affected Plant Stages** No information **Affected Plant Part** Stem **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

7.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Nasutitermes havilandi* (Desn.)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Isoptera
Family	Termitidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	The soldier can be recognized b the stout base of the nasus and the inconspicuous hump on the dorsal margin of the head viewed in profile. Habitat: A widespread species common in habitats converted from forest. Also found in lowland and hill dipterocarp forest (Tho, 1992). **Affected Plant Stages** No information **Affected Plant Part** Stem **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Y. P. Tho (1992). Termites of Peninsular Malaysia. Forest Research Institute of Malaysia. 149pp.

8.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Pinnaspis* sp. (Cockerell, 1892)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Hemiptera
Family	Diaspididae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	Morphology Species in this genus have 2-bared ducts and gland spines. The most distinctive feature is the pair of median lobes, which are united at the base by a more or less elongate zygosis; the inner edges of the lobes are parallel and very close together to the apices, appering to be fused. Second lobes, when present, small, often indicated by the ventral paraphyses. Normally the marginal ducts are larger then the dorsal ducts, the latter usually few and represented by submarginal rows, although sometimes there are submedian series. The body is elangate, with the free abdominal segments strongly lobed (Williams and Watson, 1988). **Life Cycle** No information **Affected Plant Stages** No information **Affected Plant Part** Leaf **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Anonymous (2002). Crop Protection Compendium. CAB International. 3. Williams, D. J. and Watson, G. W. (1988). The Scale Insects of the Tropical South Pacific Region Part 1 The Armoured Scales (Diaspididae). C.A.B International.211pp.

9.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Ptilocera quadridentata* (Fabricius)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Diptera
Family	Stratiomycidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	No information **Affected Plant Stages** No information **Affected Plant Part** Stem **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

10.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Schedorhinotermes javanicus* (Kemner.)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Isoptera
Family	Rhinotermitidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	No information **Affected Plant Stages** No information **Affected Plant Part** Stem **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

11.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Spodoptera litura* (Fabricus)
Common Name	Armyworm Taro caterpillar Tobacco budworm Cotton leafworm Rice cutworm Cluster caterpillar Cotton worm Egyptian cotton leafworm Tobacco caterpillar Tobacco cutworm Tobacco leaf caterpillar Common cutworm
Phyllum	Arthroptora
Class	Insecta
Order	Lepidoptera
Family	Noctuidae
Synonym	*Mamestra albisparsa* Walker *Noctua elata* Fabricius *Noctua histrionica* Fabricius *Prodenia ciligera* Guenée *Prodenia declinata* Walker *Prodenia evanescens* Butler *Prodenia glaucistriga* Walker *Prodenia litura* Fabricius *Prodenia subterminalis* Walker *Prodenia tasmanica* Guenée *Noctua litura* Fabricius *Prodenia testaceoides* Walker
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	**Morphology** Eggs Spherical, somewhat flattened, 0.6 mm in diameter, laid in batches and covered with hair scales from the tip of the abdomen of the female moth. Usually pale orange-brown or pink in colour. Egg masses measure about 4-7 mm in diameter and appear golden brown because they are covered with body scales of females (Anon., 2002) Larva

	Larva hairless, variable in colour (young larvae are light green, the later instars are dark green to brown on their backs, lighter underneath); sides of body with dark and light longitudinal bands; dorsal side with two dark semilunar spots laterally on each segment, except for the prothorax; spots on the first and eighth abdominal segments larger than others, interrupting the lateral lines on the first segment. Though the markings are variable, a bright-yellow stripe along the length of the dorsal surface is characteristic of S. litura larvae (Anon., 2002). Larval instars can be distinguished based on head capsule width ranging from 2.7 to 25 mm, and body length ranges from 2.3 to 32 mm (Anon.,2002) Pupa 15-20 mm long, red-brown; tip of abdomen with two small spines. Adult Moth, with grey-brown body, 15-20 mm long; wingspan 30-38 mm. The forewings are grey to reddish-brown with a strongly variegated pattern and paler lines along the veins (in males, bluish areas occur on the wing base and tip); the hindwings are greyish-white with grey margins, often with dark veins in S. litura (Anon.,2002). Life cycle Eggs are laid in clusters on leaves. These are covered in felt-like material. A hundred to 300 eggs per cluster have been recorded. The incubation period is 3 to 6 days. Larval developtment varies with the food eaten. It as found, for example, that larval development was completed in 21 days when larvae ere fed on maize, 18 days on tomato and groundnut, 17 days on *sawi*, 16 days on copea, and about 15 days on castor. There are 6 larval instars. The larva grows to a length of about 40 mm. When full-grown, the larva descens to the ground and prepares a cell in the soil to pupate. Pupation takes about 12 days (Chong, Ooi & Tuck, 1991) After adult emergence, peak oviposition occurs on the second night. Females mate three or four times during their lifetime, while males mate up to 10 times (Anon., 2002). **Affected Plant Stages** Flowering stage, fruiting stage and vegetative stage. **Affected Plant Part** Leaf

	Symptom and Damage On most crops, damage arises from extensive feeding by larvae, leading to complete stripping of the plants.
Host	The host range of S. litura covers at least 120 species. Among the main crop species attacked by S. litura in the tropics are *Colocasia esculenta*, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco, vegetables (aubergines, Brassica, Capsicum, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes and species of Vigna). Other hosts include ornamentals, wild plants, weeds and shade trees (for example, Leucaena leucocephala, the shade tree of cocoa plantations in Indonesia) (Anon., 2002)
Control	Integrated Pest Management practise as follow: 1. Pheromone traps to predict present of Spodoptera 2. Mechanical collection of egg masses and larvae from attacked plant. 3. Application of insecticide like *chlorprifos+cypermethrin* and *tebufenozide* (Jamaludin, Mohamad Roff & Yew, 1999)
References	4. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 5. Anonymous (2002). Crop Protection Compendium. CAB International. 6. Chong, K.K., Ooi, P.A.C. and Tuck, H. C. (1991). Crop Pests and Their Management In Malaysia. Tropical Press, Kuala Lumpur.123pp. 7. Jamaludin, S., Mohamad Roff, M. N. and Yew, N. K. (1999). Serangga Perosak Utama Sayur-Sayuran di Malaysia. Institut Penyelidikan dan Kemajuan Pertanian Malaysia, Kuala Lumpur. 6pp.

12. 0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Termes malaccensis* (Hav.)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Isoptera
Family	Termitidae
Synonym	No information
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	No information **Affected Plant Stages** No information **Affected Plant Part** Stem **Symptom and Damage** No information
Host	No information
Control	No information
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp.

13.0 PEST FACT SHEET (PAPAYA)

Spesies Name	*Xyleborus semigranosus* (Blandford)
Common Name	No information
Phyllum	Arthroptora
Class	Insecta
Order	Coleoptera
Family	Scolytidae
Synonym	*Dryocoetes bengalensis* Stebbing *Xyleborus bengalensis* Stebbing *Xyleborus crassiusculus* (Motschulsky) *Xyleborus declivigranulatus* Schedl *Xyleborus ebriosus* Niisima Xyleborus mascarenus *Hagedorn* *Xyleborus okoumeensis* Schedl *Xylosandrus crassiusculus* (Motschulsky) *Xyleborus semiopacus* Eichhoff *Xylosandrus semigranosus* (Blandford) *Xylosandrus semiopacus* (Eichhoff)
Distribution	Peninsular Malaysia (Ahmad & Ho, 1980)
Status	No information
Biology & Ecology	**Morphology** Adults Female Length 2.2-2.5 mm. Frons weakly convex, with a distinct median line, surface coarsely granulate, sparsely punctate. Antennal club solid on posterior face, no sutures present. Pronotum about as long as wide; sides weakly arcuate, anterior margin narrowly rounded, with 8 or 9 weak serrations. Elytra 1.2-1.3 times longer than wide, apex broadly rounded. Elytral declivity abrupt, convex, surface opaque with dense, confused granules and rows of long stout setae (Anon., 2002) **Biology and ecology** The important pest species in the genus Xyleborus and the related genera Xylosandrus, Xyleborinus and Euwallacea are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. Some species infest small twigs and shoots, others are found in larger branches and poles, while others are found in large timber; others may breed in material of almost any size. In general, most species bore through the bark and into the wood where an enlarged chamber of varying size and shape is constructed. The tunnels into the wood are highly variable in depth and shape, depending on the species involved in the construction. Generally only unhealthy or newly fallen material is infested, but some species are capable of attacking host plants following only a slight set-back, for example, transplanting or

	temporarily unfavourable conditions such as drought or mechanical injury. A few species have become aggressive under certain conditions, and have thereby attained the status of important pests (Anon., 2002). All species of Xyleborus and the related genera are closely associated with ambrosial fungi. Some of these fungi are phytopathogenic and all species of Xyleborus and related genera should be considered to be possible vectors of plant disease (Anon., 2002). Means of Movement and Dispersal Adult females fly readily and flight is one the main means of movement and dispersal to previously uninfected areas. Of more importance, however, is the movement of infested woody material in ship dunnage, crating, or the movement of infested seedlings or plant products such as coffee beans. Numerous species of Xyleborus and related genera have been taken in port cities from raw logs destined for saw mills, from discarded ship dunnage, and from other similar circumstances (Anon., 2002). **Affected Plant Stages** No information **Affected Plant Part** Stems **Symptom and Damage** Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.
Host	- Forest trees and shrubs - Cinchona trees
Control	No information on papaya.
References	1. Ahmad Y. and Ho T. H. (1980). List of economic pests, host plants, parasites and predators in west Malaysia (1920-1978). Ministry of Agriculture Malaysia.277pp. 2. Anonymous (2002) crop Protection Compendium. CAB International. 3. World Wide Web site at: 4. http://creatures.ifas.ufl.edu/trees/asian_ambrosia_beetle.htm

DISEASES LIST OF PAPAYA

DISEASE LIST OF PAPAYA CAUSED BY FUNGI IN MALAYSIA

	Genus	Species	Order	Family	Common Name	Parts Affected	Distribution	Verification Method	Status	Status Up to 2003
1	*Botryodiplodia*	*theobromae*	Xylaries	Hyponectriaceae	Brown pod rot	Fruits/pods	Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
2	*Choanephora*	*cucurbitarum*	Mucorales	Choanephoraceae	Fruit rot	Fruits/pod	Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
3	*Cladosporium*	sp.	No information	No information	Leaf spot, fruit rot	No information	Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
4	*Cochliobolus*	*intermedius*	Pleosporales	Pleosporaceae	Leaf spot	No information	Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
5	*Colletotrichum*	*capsici*	No information	No information	Leaf spot, fruit rot	Leaves	PM, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
6	*Colletotrichum*	*gloeosporioides*	No information	Glomerellaceae	Anthracnose	Fruits/Pods	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
7	*Colletotrichum*	sp.	No information	No information	Fruit rot	Fruits/Pods	Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
8	*Corticum*	*rolfsii*	Polyporales	Corticiaceae	Scelrotium, stem rot	Stems, fruits/pod	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
9	*Corynespora*	*cassiicola*	No information	No information	Stem/fruit spot	Stem, fruits/pod	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
10	*Fusarium*	*solani*	Hypocreales	Nectriaceae	Fruit rot	Leaves, stem	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
11	*Fusarium*	sp.	Hypocreales	No information	Fruit rot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
12	*Mycosphaerella*	*caricae*	Mycosphaerellales	Mycosphaerellaceae	Leaf disease	Leaves	PM, Sa, Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
13	*Myrothecium*	*roridum*	No information	No information	Leaf spot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
14	*Nigrospora*	*sphaerica*	Trichosphaeriales	No information	Leaf spot	No information	Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable

	Genus	Species	Order	Family	Common Name	Parts Affected	Distribution	Verification Method	Status	Status Up to 2003
15	*Periconia*	*byssoides*	No information	No information	Periconia leaf spot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
16	*Phaeoseptoria*	*papayae*	No information	No information	Leaf scab	No information	Sa	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
17	*Phoma*	sp.	Diaporthales	Valsaceae	Leaf spot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
18	*Phyllosticta*	sp.	No information	No information	No information	No information	Sa	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
19	*Phytophthora*	*nicotianae*	Pythiales	Pythiaceae	Root rot	Roots, Fruit/pods	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
20	*Phytophtora*	*palmivora*	Pythiales	Pythiaceae	Fruit and stem rot	Fruit, stem	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
21	*Pythium*	*indicum*	Saprolegniales	No information	collar, root rot	No information	PM, Swk	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
22	*Pythium*	*vexans*	Saprolegniales	No information	Root rot	leaves, root, fruit	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
23	*Pythium*	*irregulare*	Saprolegniales	No information	Root rot	leaves, root, fruit	Sa	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
24	*Pythium*	*butleri*	Saprolegniales	No information	Root rot	No information	Sa	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
25	*Pythium*	*aphanidermatum*	Saprolegniales	No information	collar, root rot	roots	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
26	*Pythium*	*middletonii*	Saprolegniales	No information	Root rot	No information	Sa	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
27	*Rhizoctonia*	sp.	No information	No information	Damping-off	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
28	*Rhizopus*	*stolonifer*	Mucorales	Mucoraceae	Fruit rot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable

	Genus	Species	Order	Family	Common Name	Parts Affected	Distribution	Verification Method	Status	Status Up to 2003
29	*Rigidoporus*	*lignosus*	Polyporales	Meripilaceae	White root	Leaves, stems, roots	PM, Sa, Swk	C2, L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
30	*Sphaerostilbe*	*repens*	No information	No information	Red root rot	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable
31	*Stilbella*	*proliferans*	No information	No information	Abortion of immature fruit	No information	PM	L1	P(2)(K.G.Singh, 1980)	A(4)pest record unreliable

DISEASE LIST OF PAPAYA CAUSED BY VIRUS IN MALAYSIA

	Genus	Species	Order	Family	Common Name	Parts Affected	Distribution	Verification Method (Ref. 2)	Status	Status Up to 2003
1	Potyvirus	Papaya Ringspot Virus	No information	Potyviridae	Papaya PRSV	Leaves, stem, fruit/pods	PM	C2, L1	P(2)(CABI, 2002)	P(9)subject to official control

REFERENCES

1. K.G.Singh (1980), A Check List of Host and Disease in Malaysia, Ministry of Agriculture
2. CAB International (2002) Crop Protection Compendium 2002 Edition
3. Compendium of Tropical Fruit Diseases – APS Press 1998; 66 - 68
4. Panduan Analisis Produktiviti Tanaman Buah-Buahan Terpilih (*A Guide to Analysis of Fruit Crop Productivity)*, Department of Agriculture Malaysia 1993; 4 - 6
5. Papaya Disease and Pest – Papaya Ringspot Virus, Department of Agriculture Malaysia 2001 (ISBN 983-047-082-2)
6. Report On The Control and Status of Papaya Ringspot Virus In Johore 1991 – 2003, Crop Protection & Plant Quarantine Unit Of Johore, October 2003

DISTRIBUTION CODE

PM	Peninsular Malaysia
Swk	Sarawak
Sa	Sabah

VERIFICATION CODE

C1	Collection Center
C2	Compendium
L1	Literature/Journal/Publication
P1	Personel Communication
S1	Survey

STATUS CODE

A(1)	Absent: no pest record
A(2)	Absent: pest no longer present
A(3)	Absent: pest record invalid
A(4)	Absent: pest record unreliable
A(5)	Absent: intercepted only
P(1)	present: in all parts of the areas
P(2)	Present: only in some areas
P(3)	Present: except in specified pest free areas
P(4)	Present: in all parts of the area here host crop(s) are grown
P(5)	Present: only in some area where host crop(s) are grown
P(6)	Present: onl in protect 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

DISEASES FACT SHEET OF PAPAYA CAUSED BY FUNGI

1.0 DISEASES FACT SHEET (PAPAYA)

Species name	***Botryodiplodia theobromae* Pat. [anamorph]** [Fruit rot] (K.G. Singh 1980) **Preferred name :** ***Lasiodiplodia theobromae* (Pat.) Groffiths & Maubl. [anamorph]** (CABI 2002)	
Common name	Brown pod rot of cocoa Diplodia pod rot of cocoa	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Sordariomycetidae
	Order	Xylariales
	Family	Hyponectriaceae
Synonyms	*Botryodiplodia ananassae* (Sacc.) Petr. *Botryodiplodia elasticae* Petch *Botryodiplodia gossypii* Ellis & Barthol *Botryodiplodia tubericola* (Ellis & Everh.) Petr. *Chaetodiplodia grisea* Petch *Diplodia ananassae* Sacc. *Diplodia cacaoicola* Henn. *Diplodia gossypina* Cooke *Diplodia natalensis* Pole-Evans *Diplodia theobromae* (Pat.) W.Nowell *Diplodia tubericola* (Ellis & Everh.) Taubenh *Lasiodiplodia triflorae* B.B. Higgins *Lasiodiplodia tubericola* Ellis & Everh. *Macrophomina vestita* Prillinger & Delacr. *Botryosphaeria rhodina* (Cooke) Arx [teleomorph] *Physalospora rhodina* Berk. & M.A. Curtis [teleomorph]	
Distribution & Status	Malaysia : Present, no further details (CABI 2002) Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	B. *theobromae* is a plurivorous wound and secondary pathogen and a saprophyte. It is soilborne, seedborne, air-borne, insect transmitted and occurs as endophytes. It sporulates readily on host tissue on incubation. Infections usually occur when there is a wound in the host tissue. Conidiomata (pycnidia) are produced with fluffy mycelium, and optimum growth is obtained at 30°C. B. *theobromae* has been reported causing stem rot of papaya in Alagoas, Brazil. (CABI 2002)	
Host Range	**Primary Hosts** : Citrus, *Theobromae cacao* (cocoa), *Arachis hypogaea* (groundnut), Gossypium (cotton), Musa (banana), *Mangifera indica* (mango), *Zea mays* (maize), Allium (onions, garlic, leek, etc), *Ananas comosus* (pineapple), *Araucaria cunninghamii* (colonial pine), *Cocos nucifera* (coconut), *Capsicum annuum* (bell pepper), Diocorea (yam), *Hevea brasiliensis* (rubber), *Persea*	

	Americana (avocado), *Solanum melongena* (aubergine) . **Secondary hosts** : *Artocarpus integer* (jack tree), *Camellia sinensis* (tea), *Cajanus cajan* (pigeon pea), *Cucumis melo* (melon), *Ipomoea batatas* (sweet potato), *Manihot esculenta* (cassava), *Musa balbisiana, Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Saccharum officinarum* (sugarcane), Sorghum. **Affected Plant Stages:** Flowering stage, fruiting stage, post-harvest, pre-emergence, seedling stage, and vegetative growing stage. **Affected Plant Parts:** Leaves, stems, roots, inflorescence, fruits/pods, seeds, and growing points
Symptoms	B. theobromae and its presumed teleomorph Botryosphaeria rhodina have been reported to cause disease symptoms on a wide variety of plant species. Leaf spots, cankers, root rots, foot rots and seed decays have been reported Descriptors: Leaves: necrotic areas; abnormal forms. Stems: canker on woody stem; gummosis or resinosis; dieback; dead hearts. Roots: soft rot of cortex. Inflorescence: discoloration panicle. Fruits/pods: lesions: black or brown; extensive mould. Seeds: rot; discolorations. Growing points: rot.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

2.0 DISEASES FACT SHEET (PAPAYA)

Species name	***Choanephora cucurbitarum* (Berk. & Ravenel) Thaxt.** [Fruit rot] (K.G. Singh 1980)	
Common name	Choanephora blossom blight Choanephora fruit rot Choanephora blight blossom blight Choanephora mould leaf and stem wet rot (Amaranthus) pod rot of cowpea premature fruit rot of cucurbits blight of watercress blossom end rot of watermelon bud rot of chilli pepper Choanephora blossom mould Choanephora rot flower blight blight of cowpea blight of potato boll rot of cotton foliar blight of beans fruit rot of Capsicum spp. fruit rot of cucurbits wet rot of bean	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Zygomycota
	Class	Zygomycetes
	Subclass	-
	Order	Mucorales
	Family	Choanephoraceae
Synonyms	*Choanephora americana* A. Møller	
Distribution & Status	Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	C. cucurbitarum is a weak parasite that grows initially on dead plants or processed plant products. It also attacks tissues that have been injured by mechanical means or by insects during feeding or oviposition. Insect damage is often associated with infection. Mycelium builds up on the affected plant tissues and enzymes are secreted to overcome the resistance of the healthy tissue, which is then invaded Sexual spores on Amaranth debris are the main source of inoculum. These thick-walled zygospores withstand adverse conditions and germinate when temperatures and moisture conditions are favourable (warm and moist) for the production of a sporangium containing sporangiospores. Sporangiospores are disseminated primarily by air currents .	

Host Range	**Primary Hosts** : Amaranthus (grain amaranth), *Cucumis sativus* (cucumber), Capsicum (peppers), *Capsicum annuum* (bell pepper), *Ipomoea batatas* (sweet potato), Cucurbitaceae (cucurbits), *Brassica oleracea* var. *botrytis* (cauliflower), *Cajanus cajan* (pigeon pea), ***Carica papaya*** **(papaya),** *Citrullus lanatus* (watermelon), *Capsicum frutescens* (chilli), *Manihot esculenta* (cassava), *Nasturtium officinale* (watercress), *Pisum sativum* (pea), *Piper nigrum* (black pepper), *Psidium guajava* (common guava), *Ricinus communis* (castor bean), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Spinacia oleracea* (spinach), *Zea mays* (maize). **Affected Plant Stages:** Pre-emergence, seedling stage, vegetative growing stage, flowering stage, fruiting stage, and post-harvest. **Affected Plant Parts:** Whole plant, leaves, stems, growing points, inflorescence, fruits/pods, and seeds.
Symptoms	C. cucurbitarum mostly attacks tissues that have been damaged by insects or mechanical means, or crops that are poorly adapted to a hot humid climate. The general appearance of Choanephora blight is similar to that of diseases caused by other Mucorales of the genera Mucor and Rhizopus. Host tissues have a hairy appearance resulting from the tall sporangiophores that produce a cluster of brown sporangiola (often referred to as conidia) at their tips. Descriptors: Whole plant: plant dead; dieback. Leaves: necrotic areas; fungal growth; honeydew or sooty mould; rot; odour. Stems: canker on woody stem; dieback; honeydew; sooty mould; rot. Growing points: dieback. Inflorescence: rot; lesions; flecking; streaks (not Poaceae); dieback. Fruits/pods: extensive mould. Seeds: rot.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

3.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Cladosporium* sp.** [Leaf spot, fruit rot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

4.0 DISEASES FACT SHEET (PAPAYA)

Species name	***Cochliobolus intermedius* Nelson** [Leaf spot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Dothideomycetidae
	Order	Pleosporales
	Family	Pleosporaceae
Synonyms	*Curvularia intermedia*	
Distribution & Status	Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

5.0 DISEASES FACT SHEET (PAPAYA)

Species name	***Colletotrichum capsici* (Syd.) E.J. Butler & Bisby** [Fruit rot] (K.G. Singh 1980)	
Common name	leaf spot of peppers fruit rot of peppers anthracnose of capsicum fruits dry rot of capsicum fruits anthracnose: pepper ripe rot: pepper	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	*Vermicularia capsici* Syd.	
Distribution & Status	Peninsular Malaysia: Present, no further details (CABI 2002) Sabah : Present (K.G. Singh 1980)	
Biology & Ecology	The fungus affects aerial parts of the plant and can be transmitted in various ways. It is known to be seed-borne and will also be transferred to new plants and plant parts after saprobic growth on dead plant tissue or in the soil, or directly via conidia from lesions on affected tissues. In these circumstances transmission presumably occurs by water-splash, although the subject has not been widely investigated for C. capsici. The fungus infects new tissues by the production of brown appressoria from germinating conidia. These appressoria penetrate the plant surface and either remain dormant or grow immediately, causing varied symptoms including the typical bordered necrotic lesions called anthracnose. The conidiomata (acervuli) are formed on dead tissue, scattered over the surface of well-developed lesions. Conidia form in large numbers as pinkish masses. The dormancy mechanisms are not studied for this species, but are probably similar to those known for other Colletotrichum species.	
Host Range	**Primary Hosts** : *Capsicum annuum* (bell pepper*Solanum melongena* (aubergine). **Secondary hosts** : *Lycopersicon esculentum* (tomato), *Vigna radiata* (bean, mung), *Solanum tuberosum* (potato), *Vigna unguiculata* (cowpea), ***Carica papaya* (papaya).** **Affected Plant Stages:** Pre-emergence, seedling stage, vegetative growing stage, flowering stage, fruiting stage, and post-harvest. **Affected Plant Parts:** Leaves.	

Symptoms	Symptoms are very varied. Small or large lesions typical of Colletotrichum infections (anthracnoses) are formed on leaves and fruits, but in other cases the disease may develop as purplish or brown patches without the formation of definite lesions. Stems and petioles may be girdled, and necrosis of inflorescences causes dieback and shrivelling. The eventual development of conidiomata with their characteristic setae are more reliably diagnostic, but by this stage the disease is well advanced. Descriptors: Leaves: necrotic areas; abnormal colours.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

6.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Colletotrichum gloeosporioides* (Penz.) Sacc. [anamorph]** [Fruit anthracnose] (K.G. Singh 1980) **Preferred name :** ***Glomerella cingulata* (Stonem.) Spauld. & Schrenk [teleomorph]** (CABI 2002)	
Common name	anthracnose brown blight (of coffee and tea) dieback (citrus) fruit rot stem canker tear stain black spot of fruit ripe rot of pepper anthracnose tear-stain	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Sordariomycetidae
	Order	
	Family	Glomerellaceae
Synonyms	No information	
Distribution & Status	Peninsular Malaysia: present, no further details (CABI 2002) (K.G. Singh 1980) Sabah: present, no further details (CABI 2002) Sarawak: present, no further details (CABI 2002)	
Biology & Ecology	Anthracnose and chocolate spot of papaya in Hawaii are caused by C. gloeosporioides. Infections are usually initiated in the early stages of fruit development, but the pathogen remains quiescent as an appressorium with infection peg or as sub-cuticular hyphae until the fruit reaches the climacteric. Conidia of this fungus are produced in lesions on leaves, and result in defoliated branch terminals and mummified inflorescences and flower bracts. Large numbers of conidia were sampled during prolonged periods of rainfall, and where these coincided with active periods of growth of the host, severe outbreaks of the disease occurred.	
Host Range	**Primary Hosts** : *Mangifera indica* (mango), *Persea americana* (avocado), *Allium cepa* (onion), Citrus, Araceae, Orchidaceae (orchids), Acacia (wattles), Allium (onions, garlic, leek, etc.), Amaranthus (grain amaranth), *Anthurium andreanum*, *Camellia sinensis* (tea), ***Carica papaya* (papaw),** *Citrus aurantiifolia* (lime), *Citrus maxima* (pummelo), *Citrus limon* (lemon), Coffea (coffee), Capsicum (peppers), *Capsicum annuum* (bell pepper), Gossypium (cotton), *Hevea brasiliensis* (rubber), *Lycopersicon esculentum* (tomato), *Manihot esculenta* (cassava).	

	Secondary hosts : *Artocarpus heterophyllus* (jackfruit), *Averrhoa carambola* (carambola), *Cajanus cajan* (pigeon pea), Cocos nucifera (coconut), Chrysanthemum (daisy), *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Daucus carota* (carrot), *Durio zibethinus* (durian), *Elaeis guineensis* (African oil palm), *Garcinia mangostana* (mangosteen), Musa (banana), *Myristica fragrans* (nutmeg), *Nephelium lappaceum* (rambutan), *Pisum sativum* (pea), Rosa (roses), Saccharum, **Affected Plant Stages:** Flowering stage, fruiting stage, post-harvest, seedling stage, and vegetative growing stage. **Affected Plant Parts:** Leaves, stems, fruits/pods, and inflorescence.
Symptoms	C. gloeosporioides causes a wide range of symptoms, depending both on the host species and the tissue attacked. On cotyledons and leaves, lesions are often dark, necrotic, angular or irregular in shape, although on some hosts (cucurbits, rubber) they may be pale with less necrosis. A more general spreading necrosis turning to a leaf blight may also occur (yam, tea). Elliptical, dark, sunken lesions can occur on stems which are necrotic and cankerous (Stylosanthes, cassava). Flower blights are characterized by a general and rapid necrosis of the petals, often spreading to peduncles as in mango blossom blight. The most characteristic lesions occur on ripening fruit where the typical anthracnose lesions of dark, sunken, circular necrotic tissue occur. Under humid conditions sporulation of the fungus occurs as pink, erumpent, pinhead-sized acervuli often arranged in concentric patterns on the necrotic tissue. These symptoms, however, are commonly caused by other fungi (including other Colletotrichum species) and by Hemipteran insects (Helopeltis spp.) whose feeding punctures also result in dark, sunken, necrotic lesions.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

7.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Colletotrichum* sp.** [Fruit rot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	*Vermicularia* sp. [Fruit rot] (K.G. Singh 1980)	
Distribution & Status	Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

8.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Corticium rolfsii Curzi [teleomorph]
[Sclerotium state] (K.G. Singh 1980)
[Basal stem rot] (K.G. Singh 1980)</td></tr>
<tr><td>Common name</td><td colspan="2">collar rot
collar rot of tomato
cotton stem & root rot
crown rot (bean)
damping-off
groundnut stem rot
leaf spot or neck rot of yams
root and stem wilt of groundnut
root rot of beans, citrus
sclerotium blight (alfalfa, soyabean)
sclerotium rot
seedling blight (sweet potato, rice)
southern blight (groundnut, alfalfa, soyabean)
southern root rot (sugarbeet)
southern sclerotial rot (sorghum, sugarbeet)
southern stem rot (groundnut, bean, soyabean)
southern wilt (bean)
white mould (groundnut, soyabean)
white rot or bulb rot of onions
wilt and fruit rot</td></tr>
<tr><td rowspan="7">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Fungi</td></tr>
<tr><td>Phylum</td><td>Basidiomycota</td></tr>
<tr><td>Class</td><td>Basidiomycetes</td></tr>
<tr><td>Subclass</td><td>Agaricomycetidae</td></tr>
<tr><td>Order</td><td>Polyporales</td></tr>
<tr><td>Family</td><td>Corticiaceae</td></tr>
<tr><td>Synonyms</td><td colspan="2">Botryobasidium rolfsii (Saccardo) Venkat.
Corticium centrifugum (Lév.) Bresad.
Hypochnus centrifugus (Lév.) Tul.
Sclerotium rolfsii var. rolfsii Saccardo
Athelia rolfsii (Curzi) C. C. Tu & Kimbr. [teleomorph]
Pellicularia rolfsii (Curzi) E. West [teleomorph]
Sclerotium rolfsii Sacc. [teleomorph]</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Peninsular Malaysia: present, no further details (CABI 2002)
Sabah: present, no further details (CABI 2002)
Sarawak: present, no further details (CABI 2002) ((K.G. Singh 1980)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">No information</td></tr>
</table>

Host Range	**Secondary hosts** : turfgrasses (turfgrasses), Araceae, *Allium cepa* (onion), *Allium sativum* (garlic), *Ananas comosus* (pineapple), *Brassica oleracea* var. *capitata* (cabbage), ***Carica papaya*** **(papaya),** *Citrullus lanatus* (watermelon), Coffea (coffee), *Cucumis sativus* (cucumber), Cucurbita, Dianthus (carnation), Dioscorea (yam), *Elettaria cardamomum* (cardamom), *Hevea brasiliensis* (rubber), *Mangifera indica* (mango), Musa (banana), *Nicotiana tabacum* (tobacco), *Solanum melongena* (aubergine), *Zingiber officinale* (ginger). **Affected Plant Stages:** Flowering stage, fruiting stage, post-harvest, pre-emergence, seedling stage, and vegetative growing stage. **Affected Plant Parts:**. Whole plant, leaves, stems, roots, inflorescence, fruits/pods, seeds, and vegetative organs.
Symptoms	No information
Control Measures	No information
Reference	1. CMI, 1992. Distribution Maps of Plant Diseases. Edition 4. Wallingford, UK: CAB International. 2. CAB International (2002) Crop Protection Compendium 2002 Edition 3. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

9.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Corynespora cassiicola* (Berk. & Curtis) Weir** [Leaf spot] (K.G. Singh 1980)	
Common name	target leaf spot of tomato stem and fruitspot of eggplant / papaya blotch disease: cucurbits fruit spot: tomato leaf spot: cotton leaf spot: tobacco leaf spot: tomato target spot: cucurbits target spot: soybean	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	*Helminthosporium casiicola* *Cercospora melonis* Cooke *Corynespora melonis* (Cooke) Lindau	
Distribution & Status	Malaysia: unconfirmed record (CABI 2002) Peninsular Malaysia : Present (K.G. Singh 1980) Sabah : Present - Occasionally serious (K.G. Singh 1980) Sarawak : Present - Occasionally serious (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : Cucurbitaceae (cucurbits), ***Carica papaya* (papaya),** *Lycopersicon esculentum* (tomato), *Solanum melongena* (aubergine), *Arachis hypogaea* (groundnut), Cucumis sativus (cucumber), *Hevea brasiliensis* (rubber). **Secondary hosts** : No information **Affected Plant Stages:** Post-harvest. **Affected Plant Parts:** Leaves, stems, and fruits/pods.	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

10.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Fusarium solani (Martius) Sacc. [anamorph]
[Fruit rot] (K.G. Singh 1980)
<u>Preferred name</u> :
Nectria haematococca (Wollenw.) Gerlach [teleomorph] (CABI 2002)</td></tr>
<tr><td>Common name</td><td colspan="2">dry rot of potato
tuber rot
storage rot of yam
sudden death syndrome of soyabean
foot rot of peas and beans
localized ring rot of ginger</td></tr>
<tr><td rowspan="7">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Fungi</td></tr>
<tr><td>Phylum</td><td>Ascomycota</td></tr>
<tr><td>Class</td><td>Ascomycetes</td></tr>
<tr><td>Subclass</td><td>Sordariomycetidae</td></tr>
<tr><td>Order</td><td>Hypocreales</td></tr>
<tr><td>Family</td><td>Nectriaceae</td></tr>
<tr><td>Synonyms</td><td colspan="2">Fusarium solani var. martii (Appel & Wollenw.) Wollenw.
Fusarium solani var. striatum (Sherbakov) Wollenw.</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Peninsular Malaysia : Present (K.G. Singh 1980)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">No information</td></tr>
<tr><td>Host Range</td><td colspan="2">Primary Hosts : Solanum tuberosum (potato), Dioscorea (yam), Solanum melongena (aubergine), Lycopersicon esculentum (tomato), Cucurbitaceae (cucurbits), Allium (onions, garlic, leek, etc.), Carica papaya (papaya), Capsicum annuum (bell pepper), Manihot esculenta (cassava).

Secondary hosts : Poaceae (cereals), Allium cepa (onion), Arachis hypogaea (groundnut), Asparagus officinalis (asparagus), Cocos nucifera (coconut), Citrullus lanatus (watermelon), Cymbidium, Cucumis melo (melon), Cucurbita, Daucus carota (carrot), Dianthus caryophyllus (carnation), Helianthus annuus (sunflower), Mangifera indica (mango), Musa (banana), Nicotiana tabacum (tobacco), Oryza sativa (rice), Phaseolus vulgaris (common bean), Piper nigrum (black pepper), Psidium guajava (common guava), Rosa (roses), Zea mays (maize), Zingiber officinale (ginger).

Affected Plant Stages: Seedling stage, and vegetative growing stage.

Affected Plant Parts: Whole plant, leaves, stems, roots, and vegetative organs.</td></tr>
<tr><td>Symptoms</td><td colspan="2">No information</td></tr>
</table>

Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

11.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Fusarium* sp.** [Fruit rot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Sordariomycetidae
	Order	Hypocreales
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

12.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Mycosphaerella caricae* Syd.** [Leaf disease] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Dothideomycetidae
	Order	Mycosphaerellales
	Family	Mycosphaerellaceae
Synonyms	No information	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980) Sabah : Present (K.G. Singh 1980) Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

13.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Myrothecium roridum* Tode** [Leaf disease] (K.G. Singh 1980)	
Common name	blight: eggplant leaf spot: coffee ring rot: tomato stem necrosis: coffee	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Malaysia: present, no further details (CABI 2002) Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : Coffea (coffee), *Lycopersicon esculentum* (tomato), *Arachis hypogaea* (groundnut), ***Carica papaya* (papaya),** *Cucumis melo* (melon), *Lactuca sativa* (lettuce), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), **Secondary hosts** : No information **Affected Plant Stages:** Post-harvest. **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31 3. CMI, 1984. Distribution Maps of Plant Diseases, Map No.458. Wallingford, UK: CAB International.	

14.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Nigrospora sphaerica* (Sacc.) Mason** [Leaf spot] (K.G. Singh 1980) **Preferred name :** ***Khuskia oryzae* Huds.** (CABI 2002)	
Common name	cob rot of maize squirter disease: banana stalk rot: maize stalk rot: rice	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Sordariomycetidae
	Order	Trichosphaeriales
	Family	
Synonyms	*Nigrospora gossypii* Jacz. *Nigrospora oryzae* (Berk. & Broome) Petch	
Distribution & Status	Sarawak : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	*Brassica oleracea* var. *botrytis* (cauliflower), Citrus, *Citrus sinensis* (navel orange), *Helianthus annuus* (sunflower*Oryza sativa* (rice), *Piper betle* (betel pepper), *Zea mays* (maize), *Zingiber officinale* (ginger). **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

15.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Periconia byssoides* Pers. Ex Schw.** [Leaf spot] (K.G. Singh 1980)	
Common name	Periconia leaf spot	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	
	Class	Hyphomycetes
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

16.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Phaeoseptoria papayae* Speg.** [Leaf scab] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Sabah : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

17.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Phoma* sp.** [Leaf spot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Ascomycota
	Class	Ascomycetes
	Subclass	Sordariomycetidae
	Order	Diaporthales
	Family	Valsaceae
Synonyms	No information	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

18.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Phyllosticta* sp.** [On leaves] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Sabah : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages:** No information **Affected Plant Parts:** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

19.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Phytophthora nicotianae var. parasitica (Dastur) G. M. Waterh.
[Root rot] (K.G. Singh 1980)
<u>Preferred name</u> :
Phytophthora nicotianae Breda de Haan (CABI 2002)</td></tr>
<tr><td>Common name</td><td colspan="2">black shank
buckeye
fruit rot
stem blight</td></tr>
<tr><td rowspan="7">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Chromista</td></tr>
<tr><td>Phylum</td><td>Oomycota</td></tr>
<tr><td>Class</td><td>Oomycetes</td></tr>
<tr><td>Subclass</td><td></td></tr>
<tr><td>Order</td><td>Pythiales</td></tr>
<tr><td>Family</td><td>Pythiaceae</td></tr>
<tr><td>Synonyms</td><td colspan="2">Phytophthora allii Sawada
Phytophthora formosana Sawada
Phytophthora imperfecta var. nicotianae (Breda de Haan) Sarej.
Phytophthora lycopersici Sawada
Phytophthora manoana Sideris
Phytophthora melongenae Sawada
Phytophthora parasitica Dastur
Phytophthora parasitica var. nicotianae (Breda de Haan) Tucker
Phytophthora parasitica var. piperina Dastur
Phytophthora parasitica var. rhei G. H. Godfrey
Phytophthora ricini Sawada
Phytophthora tabaci Sawada
Phytophthora terrestris Sherb.</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Peninsular Malaysia: widespread (CABI 2002)
Sabah: widespread (CABI 2002) (K.G. Singh 1980)
Sarawak: widespread (CABI 2002)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2"><u>Life Cycle</u>

The life cycle of P. nicotianae is diplobiontic, similar to that of angiosperms and mammals. Coenocytic, diploid, vegetative mycelium is the dominant phase and produces thick-walled, resistant chlamydospores. The chlamydospores become separated from their subtending mycelium and persist in the soil, forming the primary inoculum source. Under suitable environmental conditions, chlamydospores germinate and produce vegetative hyphae or sporangia which initiate asexual reproduction. Sporangia are also formed by mycelial hyphae in the presence of water (flooding), which is essential for this process. Zoospores are produced inside the sporangium by mitotic division of nuclei, followed by protoplasmic cleavage, and are liberated via the sporangial papilla which dissolves. The reniform zoospores are highly motile and have two flagellae, one long and smooth, the other shorter and bearing a row</td></tr>
</table>

	of hairs (heterokont). Zoospores swim around for a while, and may swarm (aggregate) in response to a suitable stimulus, such as a host-plant exudate. They then round up and encyst, casting off their flagellae. Cysts either germinate by hyphae, or may produce another zoospore which swims away. Zoopores infect hosts via root hairs or stomata, if dispersed to surface water films on aerial parts. Mycelial growth follows inside the host tissues, with the production of more sporangia on root surfaces, or on leaf tissues, repeating the asexual cycle - the multiplication phase. The mycelium is bisexual and produces oogonia and antheridia in response to steroid hormones secreted by the mycelia of an opposite mating type. Sex organs are only formed when opposite mating types interact, but the frequency of mating under natural conditions is unknown. A series of nuclear divisions in the antheridium and oogonium produce haploid nuclei which function as gametes. The antheridial nucleus moves to the oogonial nucleus via a fertilization tube and produces an oospore, which has a thick, resistant wall, and germinates to produce hyphae or a sporangium.
Host Range	**Primary Hosts** : Citrus, *Lycopersicon esculentum* (tomato), *Nicotiana tabacum* (tobacco). **Secondary hosts** : *Ananas comosus* (pineapple), ***Carica papaya* (papaya),** Capsicum (peppers), *Fragaria ananassa* (strawberry), *Psidium guajava* (common guava), *Solanum melongena* (aubergine). **Affected Plant Stages:** Fruiting stage, pre-emergence, seedling stage, vegetative growing stage, and post-harvest. **Affected Plant Parts:** Whole plant, leaves, stems, roots, fruits/pods, and growing points.
Symptoms	A variety of root and fruit rots are produced on Capsicum spp., avocado, strawberry, pineapple, **papaya**, guava, aubergine, castor bean, Gossypium species, lucerne, rhubarb, sesame and Cinchona officinalis, all characterized by brown, water-soaked lesions on fruits or pods and a brown/black discoloration of roots. Descriptors: Whole plant: damping off. Leaves: necrotic areas; abnormal colours; abnormal forms; wilting; rot. Stems: discoloration of bark; canker on woody stem; gummosis or resinosis; mould growth on lesion; internal discoloration; wilt. Roots: soft rot of cortex; rot of wood; necrotic streaks or lesions. Fruits/pods: lesions: black or brown; abnormal shape; extensive mould; ooze. Growing points: rot.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

20.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Phytophthora palmivora (E. J. Butler) E. J. Butler.
(CABI 2002)
[Fruit and collar rot] (K.G. Singh 1980)</td></tr>
<tr><td>Common name</td><td colspan="2">black pod rot of cocoa
black stripe
brown rot
cocoa black pod
coconut budrot
fruit and stem rot of papaya
gummosis of Citrus spp.
leaf fall
premature nutfall
stem canker
stem canker of cacao</td></tr>
<tr><td rowspan="8">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Chromista</td></tr>
<tr><td>Phylum</td><td>Oomycota</td></tr>
<tr><td>Class</td><td>Oomycetes</td></tr>
<tr><td>Subclass</td><td></td></tr>
<tr><td>Order</td><td>Pythiales</td></tr>
<tr><td>Family</td><td>Pythiaceae</td></tr>
<tr><td>Synonyms</td><td colspan="2">Phytophthora arecae (L. C. Coleman) Pethybr.
Phytophthora cactorum var. arecae (L. C. Coleman) Sacc. & Trotter
Phytophthora faberi Maubl.
Phytophthora hevae A. W. Thomps.
Phytophthora omnivora var. arecae L. C. Coleman
Phytophthora palmivora var. heveae (A. W. Thomps.) Orellana
Phytophthora palmivora var. theobromae (L. C. Coleman) Orellana
Phytophthora theobromae L. C. Coleman</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Peninsular Malaysia: widespread (CABI 2002)
Sabah: widespread (CABI 2002)
Sarawak: widespread (CABI 2002) (K.G. Singh 1980)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">temperature act as the deciding factor for the type of germination induced, high temperatures stimulate direct germination of sporangia while low temperature exposure favours indirect germination. Zoospores (zoosporangia) are produced inside the sporangium by mitotic division of nuclei, followed by protoplasmic cleavage, and are liberated via the sporangial papilla, which dissolves. The reniform zoospores are uninucleate with no cell wall but have a carbohydrate cell coat and are highly motile. They are biflagellate, with one long and smooth (whiplash) flagellum, and the other shorter (tinsel), bearing a row of lateral hairs. Zoospores with such flagella characteristics are considered to be heterokont, indicating a relationship with algae. Zoospores swim around for a while, and may swarm (aggregate) in response to a suitable stimulus, such as chemical and electrical signals generated by host plants. They then round up and encyst, casting off their flagella.</td></tr>
</table>

	Matured cysts first absorb calcium ions to trigger germination. In the absence of exogenous supply of nutrients, germ tube growth is halted and a secondary zoospore is produced. If exogenous nutrients are available, the germ tube continues to grow until it penetrates the host by forming an appresorium at the tip. The germ tubes infect hosts via root hairs or leaf stomata, if dispersed to surface water films and in primary infections from aerial parts. Mycelial growth inside the host tissues follows, with the production of more sporangia on root surfaces, or on leaf tissues, repeating the asexual cycle - the multiplication phase. The mycelium is bisexual and produces oogonia and antheridia in response to steroid hormones secreted by mycelia of an opposite mating type. Sex organs are only formed when opposite mating types (termed A1 and A2) interact, but the frequency of mating under natural conditions is unknown. A series of nuclear divisions in the antheridium and oogonium produce haploid nuclei, which function as gametes. In the sexual process of P. palmivora, the oogonium grows through the antheridium, which deposits its nucleus into the oogonium, fertilization occurs, and a diploid oospore produced. The oospore has a thick, resistant wall, capable of withstanding unfavourable environmental conditions for many years and can germinate to produce hyphae or a sporangium. Chlamydospores and oospores (when formed) act as survival structures allowing the fungus to persist in the soil and be distributed.
Host Range	**Primary Hosts** : *Areca catechu* (betelnut palm), *Cocos nucifera* (coconut), ***Carica papaya*** **(papaya),** *Hevea brasiliensis* (rubber), *Theobroma cacao* (cocoa). **Secondary hosts** : *Piper nigrum* (black pepper), *Durio zibethinus* (durian), *Myristica fragrans* (nutmeg), *Manihot esculenta* (cassava), *Ficus carica* (common fig), *Ananas comosus* (pineapple), *Elaeis guineensis* (African oil palm), Annona, Citrus. **Affected Plant Stages:** Flowering stage, fruiting stage, pre-emergence, seedling stage, vegetative growing stage, and post-harvest. **Affected Plant Parts:** Whole plant, leaves, stems, roots, inflorescence, fruits/pods, and growing points.
Symptoms	Older regions of the stem also become infected after extended rainy periods and develop horizontal, water-soaked lesions along leaf scars. Lateral roots are infected first, and then the disease spreads to the taproot and produces a brown, soft-shredded system. Infected trees become stunted and leaves turn yellow and wilt. Plants are susceptible at all ages but roots of young seedlings are most susceptible. Infections result in wilting, leaf chlorosis and hanging limply; and in advanced stages defoliation and death. At that stage, the lateral roots and taproots are entirely destroyed and a foul odour often emanates from diseased trees.

Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31 3. Compendium of Tropical Fruit Disease – APS Press, 1998; 61-62

21.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Pythium indicum* Balakrishnan** [Collar rot] (K.G. Singh 1980) **Preferred name :** ***Pythium deliense* Meurs** (CABI 2002) [Seedling root rot] (K.G. Singh 1980)	
Common name	damping-off: seedlings	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Chromista
	Phylum	Oomycota
	Class	Oomycetes
	Subclass	
	Order	Saprolegniales
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia: present, no further details (CABI 2002) (K.G. Singh 1980) Sarawak: present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : *Nicotiana tabacum* (tobacco), *Cucumis sativus* (cucumber), *Lycopersicon esculentum* (tomato), *Zingiber officinale* (ginger). **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

22.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Pythium vexans* de Bary** [Seedling root rot] (K.G. Singh 1980)	
Common name	damping off water rot	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Chromista
	Phylum	Oomycota
	Class	Oomycetes
	Subclass	
	Order	Saprolegniales
	Family	
Synonyms	*Pythium allantocladon* Sideris *Pythium ascophallon* Sideris *Pythium complectens* Braun *Pythium piperinum* Dastur	
Distribution & Status	Peninsular Malaysia: present, no further details (CABI 2002) Sabah: serious and economically important (CABI 2002) (K.G. Singh 1980) Sarawak: present, no further details (CABI 2002)	
Biology & Ecology	P. vexans survives in soil by means of zoospores and sporangia for short and intermediate periods, and by means of oospores for longer periods. The oospores germinate indirectly by releasing zoospores. The zoospores swim around in water and infect the roots of host plants. Mycelial growth occurs between 5 and 35°C (optimum 30°C). Peach stunting induced by P. vexans is more severe under high moisture conditions.	
Host Range	**Primary Hosts** : *Ananas comosus* (pineapple), Annona, Anthurium, Brassica, Camellia, Carica, ***Carica papaya*** **(papaya),** Citrus, Cinchona, *Citrullus lanatus* (watermelon), Dianthus (carnation), *Elaeis guineensis* (African oil palm), *Hevea brasiliensis* (rubber), *Lycopersicon esculentum* (tomato), *Solanum tuberosum* (potato), *Spinacia oleracea* (spinach), Theobroma, *Theobroma cacao* (cocoa), *Zingiber officinale* (ginger). **Secondary hosts** : Malus (ornamental species apple). **Affected Plant Stages :** Flowering stage, fruiting stage, pre-emergence, seedling stage, and vegetative growing stage. **Affected Plant Parts :** Whole plant, leaves, roots, and fruits/pods.	
Symptoms	The root rot symptoms caused by P. vexans are similar to those caused by other Pythium species. On small ohia (Metrosideros collina subsp. polymorpha) seedlings (2.5 cm high), P. vexans caused extensive necrosis of the root system. The upper part of the seedlings wilted and eventually died.	

Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

23.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Pythium irregulare Buisman
[Seedling root rot] (K.G. Singh 1980)</td></tr>
<tr><td>Common name</td><td colspan="2">cavity spot: carrot
crown rot: cucumber
damping-off
dieback: carrot
red root rot: corn
replant disease: apple
root rot
root rot: conifers
root-forking disease: alfalfa
rootlet disease: alfalfa
seedling death: Pinus
sour cherry
black: beet vascular necrosis
damping-off: beet
root rot: broadleaved plants
root rot: conifers
tree decline: peach</td></tr>
<tr><td rowspan="8">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Chromista</td></tr>
<tr><td>Phylum</td><td>Oomycota</td></tr>
<tr><td>Class</td><td>Oomycetes</td></tr>
<tr><td>Subclass</td><td></td></tr>
<tr><td>Order</td><td>Saprolegniales</td></tr>
<tr><td>Family</td><td></td></tr>
<tr><td>Synonyms</td><td colspan="2">No information</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Sabah: present, no further details (CABI 2002) (K.G. Singh 1980)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">P. irregulare survives in soil and in infected plant debris as oospores and hyphal swellings. It germinates in response to volatile products released from germinating seeds. Its optimum temperature for growth is about 30°C. It is pathogenic to many plants, especially seedlings. Dispersal is by mycelial growth, and long distance dispersal is through movement of infected plants and soil.

Strains of P. irregulare contain double-stranded RNA and virus-like particles. P. irregulare produces metabolites toxic to wheat.

P. irregulare synergistically interacts with Rhizoctonia solani on Alstroemeria, and with Gaeumannomyces graminis var. tritici on wheat and rye-grass. P. irregulare and other species of Pythium are synergists of the herbicide glyphosate. Trifuralin increased root rot caused by P. irregulare and other root pathogens. Herbicide (dimethyl tetrachloroterephthalate) treatment increased root disease severity of turnip and decreased yield, and increased the frequency of isolation of P. irregulare and other species of Pythium.</td></tr>
</table>

Host Range	**Primary Hosts** : Fabaceae (leguminous plants), Poaceae (cereals), Beta, Brassica. **Secondary hosts** : Allium (onions, garlic, leek, etc.), Alstroemeria (Inca lily), *Citrullus lanatus* (watermelon), Capsicum frutescens (chilli), Gerbera (Barbeton daisy), *Lactuca sativa* (lettuce), *Nicotiana tabacum* (tobacco), Phacelia, Phaseolus (beans), *Spinacia oleracea* (spinach), *Allium cepa* (onion), *Arctium lappa* (burdock), *Cajanus cajan* (pigeon pea), *Cucumis sativus* (cucumber), *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), *Lycopersicon esculentum* (tomato), *Oryza sativa* (rice), *Phaseolus vulgaris* (common bean), *Solanum melongena* (aubergine), *Zea mays* (maize). **Affected Plant Stages :** Pre-emergence, seedling stage, and vegetative growing stage. **Affected Plant Parts :** Whole plant, stems, and roots.
Symptoms	No information
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

24.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Pythium butleri* Subramaniam** [Seedling root rot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Chromista
	Phylum	Oomycota
	Class	Oomycetes
	Subclass	
	Order	Saprolegniales
	Family	
Synonyms	No information	
Distribution & Status	Sabah : Ocasionally serious (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : *Allium cepa* (onion), *Cucumis melo* (melon), *Lycopersicon esculentum (*tomato*Solanum tuberosum* (potato). **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

25.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Pythium aphanidermatum (Edson) Fitzp.
[Root and collar rot] (K.G. Singh 1980)</td></tr>
<tr><td>Common name</td><td colspan="2">damping-off
nécrose du collet
collar rot
black leg of seedlings
damping-off: seedlings
stem rot of seedlings
water rot</td></tr>
<tr><td rowspan="7">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Chromista</td></tr>
<tr><td>Phylum</td><td>Oomycota</td></tr>
<tr><td>Class</td><td>Oomycetes</td></tr>
<tr><td>Subclass</td><td></td></tr>
<tr><td>Order</td><td>Saprolegniales</td></tr>
<tr><td>Family</td><td></td></tr>
<tr><td>Synonyms</td><td colspan="2">No information</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Malaysia: present, no further details (CABI 2002)
Peninsular Malaysia : Serious and economically important (K.G. Singh 1980)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">Thick-walled oospores are the primary survival structures of P. aphanidermatum; they are resistant to desiccation and can survive in soil for long periods in the absence of suitable hosts or organic substrates that support saprobic growth.</td></tr>
<tr><td>Host Range</td><td colspan="2">Primary Hosts : Lycopersicon esculentum (tomato), Arachis hypogaea (groundnut), Brassica, Brassica oleracea var. botrytis (cauliflower), Brassica oleracea var. capitata (cabbageCarica papaya (papaya), Citrullus lanatus (watermelon), Cucumis sativus (cucumber), Curcuma longa (turmeric), Daucus carota (carrot), Dianthus caryophyllus (carnation), Solanum melongena (aubergine), Spinacia oleracea (spinach), Zea mays (maize), Zingiber officinale (ginger).

Secondary hosts : No information

Affected Plant Stages : Pre-emergence, seedling stage, vegetative growing stage, and post-harvest.

Affected Plant Parts : Whole plant, roots, and vegetative organs.</td></tr>
<tr><td>Symptoms</td><td colspan="2">Pre-emergence damping-off: Failure of seedling to emerge after planting. Recovered seed has a watery rot, if the shoot or root emerges it has a dark necrosis. A number of other pathogens can cause similar symptoms, so pathogen isolation and identification is needed to confirm diagnosis.</td></tr>
</table>

	Post-emergence damping-off: The seedling emerges from the soil but dies soon afterwards. The roots, hypocotyl and perhaps the crown of the plant will be necrotic and have a water-soaked appearance. For some hosts, once the plant has reached a certain stage after emergence, infections by the pathogen are no longer lethal, but they can still have a significant impact on plant growth and yield. Apart from stunting of plant growth there may not be any overt symptoms of infection other than necrotic roots. In cases where root infection is heavy, wilting of plants may be observed in warm or windy weather. Foliar symptoms of nutrient deficiency also may be observed due to extensive root rotting preventing the uptake of nutrients. Post harvest: Water-soaked lesions or a watery rot of the tissue. Under conditions of higher humidity a cottony white mycelium may be observed on the tissue.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

26.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Pythium middletonii* Sparrow** [Seedling root rot] (K.G. Singh 1980)	
Common name	damping-off: soybean damping-off: vegetables root rot: conifer seedlings	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Chromista
	Phylum	Oomycota
	Class	Oomycetes
	Subclass	
	Order	Saprolegniales
	Family	
Synonyms	No information	
Distribution & Status	Sabah : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

27.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Rhizoctonia* sp.** [Damping-off] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Anamorphic fungi
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

28.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Rhizopus stolonifer* (Ehrenb.) Lind** [Fruit rot] (K.G. Singh 1980)	
Common name	No information	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	Zygomycota
	Class	Zygomycetes
	Subclass	
	Order	Mucorales
	Family	Mucoraceae
Synonyms	*Rhizopus nigricans* Ehrenb.	
Distribution & Status	Peninsular Malaysia : Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : *Solanum melongena* (aubergine), *Arachis hypogaea Ipomoea batatas* (sweet potato), *Luffa aegyptiaca* (loofah), *Lycopersicon esculentum* (tomato), *Zea mays* (maize), *Zingiber officinale* (ginger). **Secondary hosts** : No information **Affected Plant Stages :** Post-harvest. **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31	

29.0 DISEASE FACT SHEET (PAPAYA)

<table>
<tr><td>Species name</td><td colspan="2">Rigidoporus lignosus (Klotzsch) Imazeki
[White root] (K.G. Singh 1980)
<u>Preferred name</u> :
Rigidoporus microporus (Fr.) Overeem (CABI 2002)</td></tr>
<tr><td>Common name</td><td colspan="2">root rot disease
white cocoa root disease
white Hevea spp. root disease
white root disease of rubber
white root rot
white thread</td></tr>
<tr><td rowspan="8">Taxonomic Position</td><td>Domain</td><td>Eukaryota</td></tr>
<tr><td>Kingdom</td><td>Fungi</td></tr>
<tr><td>Phylum</td><td>Basidiomycota</td></tr>
<tr><td>Class</td><td>Basidiomycetes</td></tr>
<tr><td>Subclass</td><td>Agaricomycetidae</td></tr>
<tr><td>Order</td><td>Polyporales</td></tr>
<tr><td>Family</td><td>Meripilaceae</td></tr>
<tr><td>Synonyms</td><td colspan="2">Rigidoporus lignosus (Klotzsch) Imazeki
Fomes auberianus (Mont.) Murrill
Fomes lignosus (Klotzsch) Bres.
Fomes semitostus Berk.
Leptoporus lignosus (Klotzsch) R. Heim
Oxyporus auberianus (Mont.) Kreisel
Polyporus auberianus Mont.
Polyporus lignosus Klotzsch</td></tr>
<tr><td>Distribution & Status</td><td colspan="2">Peninsular Malaysia: widespread (CABI 2002) (K.G. Singh 1980)
Sabah: restricted distribution (CABI 2002)
Sarawak: restricted distribution (CABI 2002)</td></tr>
<tr><td>Biology & Ecology</td><td colspan="2">R. lignosus is a rhizomorphic root-infecting fungus with an ectotrophic growth habit. The rhizomorphs extend ahead of the root rot and spread the disease to the tree collar and to other roots of the infected tree. Root contact spreads white root disease from a diseased tree to the roots of adjacent healthy trees. The infected trees are killed, thus forming vacant patches in plantations.</td></tr>
<tr><td>Host Range</td><td colspan="2">Primary Hosts : Hevea brasiliensis (rubber), Theobroma cacao (cocoa).

Secondary hosts : Cocos nucifera (coconut), Coffea (coffee), Elaeis guineensis (African oil palm), Ipomoea batatas (sweet potato), Manihot esculenta (cassava), Nephelium lappaceum (rambutan), Piper nigrum (black pepper), Solanum melongena (aubergine).

Affected Plant Stages : Flowering stage, fruiting stage, seedling stage, and vegetative growing stage.</td></tr>
</table>

	Affected Plant Parts : Whole plant, leaves, stems, roots, and inflorescence.
Symptoms	Leaves lose their lustre, green colour and normal curvature. Leaves appear leathery and curve downwards instead of the normal boat-shape; they discolour from deep-green to increasingly yellowish-brown. Initially, the discoloration of the foliage may affect only one branch, but it later spreads to the whole canopy. Infected trees may flower and fruit off-season. Eventually, leaves drop, branches die back and infected trees die, leaving large vacant spaces in severely attacked fields. On roots, networks of rhizomorphs are firmly attached. The growing ends of rhizomorphs form whitish fans. Mature rhizomorphs are brownish or may assume the colour of the surrounding soil. Severely infected roots are soft and watery with a creamy colour. Characteristic fruiting bodies form on tree collars.
Control Measures	No information
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31

30.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Sphaerostilbe repens* Berk. & Br.** [Root rot] (K.G. Singh 1980)	
Common name	Violet Root Rot Red Rot	
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia: Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31 3. http://www.hort.purdue.edu/newcrop/duke_energy/Carica_papaya.html (26 April 2004) 4. http://www.apsnet.org/online/common/names/tea.asp (26 April 2004) 5. http://www.hort.purdue.edu/newcrop/duke_energy/Hevea_brasiliensis.html (26 April 2004)	

31.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Stilbella proliferans* F.L. Stevens** [Abortion of immature fruits] (K.G. Singh 1980)	
Common name		
Taxonomic Position	**Domain**	Eukaryota
	Kingdom	Fungi
	Phylum	
	Class	
	Subclass	
	Order	
	Family	
Synonyms	No information	
Distribution & Status	Peninsular Malaysia: Present (K.G. Singh 1980)	
Biology & Ecology	No information	
Host Range	**Primary Hosts** : No information **Secondary hosts** : No information **Affected Plant Stages :** No information **Affected Plant Parts :** No information	
Symptoms	No information	
Control Measures	No information	
Reference	1. K.G. Singh (1980) A Check List of Host and Disease in Malaysia Bulletin No. 154; 30-31 2. http://www.hort.purdue.edu/newcrop/duke_energy/Carica_papaya.html (26 April 2004) 3. http://www.apsnet.org/online/common/names/tea.asp (26 April 2004) 4. http://www.hort.purdue.edu/newcrop/duke_energy/Hevea_brasiliensis.html (26 April 2004)	

DISEASE FACT SHEET OF PAPAYA CAUSED BY VIRUS

1.0 DISEASE FACT SHEET (PAPAYA)

Species name	***Papaya Ringspot Virus***	
Common name	papaya PRSV - strain P: papaya cucurbits PRSV - strain W: watermelon	
Taxonomic Position	**Virus Group**	Virus
	Family	Potyviridae
	Genus	Potyvirus
Synonyms	papaw distortion ringspot virus papaw mosaic virus papaw ringspot virus papaya distortion mosaic virus papaya distortion ringspot virus papaya leaf distortion virus papaya ringspot potyvirus	
Distribution & Status	Peninsular Malaysia : Present in Johore State only (confined to the districts of Johor Bahru, Kota Tinggi, Pontian and Kluang) – under official control	
Biology & Ecology	The host range of PRSV is limited to plants in the families Caricaceae, Cucurbitaceae and Chenopodiaceae. Two types of PRSV are recognized: PRSV-p and PRSV-w. PRSV-p infects both papaya and cucurbits, whereas PRSV-w infects cucurbits but not papaya. PRSV-P is transmitted in nature by several species of aphids in a non-persistant manner. More than 20 species of aphids have been experimentally tested for PRSV-P transmission with positive results, including Myzus persicae, Aphis coreopsidis, A. craccivora, A. fabae, A. gossypii and Toxoptera citricidus. Although several species of Cucurbitaceae are susceptible to PRSV-P, they are apparently not important as alternative hosts for the virus. The spread of PRSV-P into and within an orchard is primarily from papaya to papaya. The introduction of the virus into a new orchard always comes from outside, primarily from diseased papaya trees. The amount of primary infection is directly related to the distance from the infected papaya. Once the virus is introduced into the orchard, secondary infection will occur and all plants can become infected in 3-7 months. A slower spread of PRSV-P can occur in areas with a reduced population of aphids, as was reported for a partially isolated region of Sao Paulo, Brazil.	
Host Range	**Primary Hosts** : Carica papaya (papaya). **Secondary hosts** : Cucurbitaceae (cucurbits). **Affected Plant Stages :** Flowering stage, fruiting stage, seedling stage, and vegetative growing stage.	

	Affected Plant Parts : Whole plant, leaves, stems, and fruits/pods.
Symptoms	Papaya plants are susceptible to PRSV-P at any age and generally show symptoms 2-3 weeks after inoculation. Symptoms may vary in intensity according to the age at which the plant becomes infected and the strain of the virus. Leaf symptoms are characterized by intense yellow mosaic and leaf distortion. The leaf laminae are markedly reduced in size, and may develop a shoestring appearance. Dark-green blisters may be present and mosaic may also occur on leaves. Oily streaks on the stem and petioles of the leaves are frequently observed on diseased plants. Dark-green rings are almost always present on fruits. The number of rings on the fruit can vary, and the rings become less distinct as the fruit mature and yellow. The canopy of diseased plants become smaller due to the development of smaller leaves, reduced petioles and stunting. Fruit yield of affected plants is markedly lower than that of healthy plants. Trees infected at a very young age never produce marketable fruit but rarely die.
Control Measures	PRSV is controlled by preventive practices that reduce or delay the spread of the virus within the orchard. These practices include the use of virus-free seedlings to start new crops, planting in partially isolated areas or as far as possible from old infected papayas avoidance of cucurbit plants in or near the orchard, and systematic weed control to reduce the aphid population. However, diseased papayas were completely eliminated by the official authorities.
Reference	1. CAB International (2002) Crop Protection Compendium 2002 Edition 2. Compendium of Tropical Fruit Diseases – APS Press 1998; 66 - 68 3. Panduan Analisis Produktiviti Tanaman Buah-Buahan Terpilih (*A Guide to Analysis of Fruit Crop Productivity),* Department of Agriculture Malaysia 1993; 4 - 6 4. Papaya Disease and Pest – Papaya Ringspot Virus, Department of Agriculture Malaysia 2001 (ISBN 983-047-082-2) 5. Report On The Control and Status of Papaya Ringspot Virus In The State of Johore 1991 – 2003, Crop Protection & Plant Quarantine Unit Of Johore October 2003