19th International OIL PALM Conference

INNOVATION AND SUSTAINABILITY IN OIL PALM
nourishing people and protecting the planet

September 26th, 27th, and 28th 2018
Cartagena de Indias Convention Center, Colombia

fedepalma | cenipalma

Oil Palm Pestalotiopsis Leaf Spot Disease Endemic In Southeast Asia Is Attributed To A Complex Of Synergisms Between Microbial Pathogens And Not By A Singular Pathogen

Tasren Mahamooth, Tan Swee Sian, Raimathy Kanavedee, Goh You Keng & Patrick Ng

AA RESOURCES — AA RESEARCH

Advanced Agriecological Research Sdn. Bhd. (Malaysia)

An associate company of
Kuala Lumpur Kepong Berhad
& Boustead Plantations Berhad

PESTALOTIOPSIS LEAF SPOT DISEASE in LATIN AMERICA

Symptoms:
Appearance of brown spots with yellowish haloes which quickly turn brown and necrosis spreads over the leaf parenchyma

Pathogen(s):

- ***Pestalotiopsis palmarum*** (Labarca *et al*., 2006)
- Escalante *et al*., (2010) reported that the disease was attributed to a **fungal complex involving *P. palmarum, P. glandicula, Colletotrichum, Curvularia, Gloesporium*** **and *Helminthosporium.***

Insect vectors (Lepidoptera insect vectors and Hemiptera (*Leptopharsa gibbicarina*). Disease severity of *Pestalotiopsis* damage increased in the presence of pest outbreaks.

PESTALOTIOPSIS LEAF SPOT DISEASE in LATIN AMERICA

Insect vectors (Lepidoptera insect vectors and Hemiptera (***Leptopharsa gibbicarina***)).
Disease severity of *Pestalotiopsis* damage increased in the presence of pest outbreaks.

Hemiptera insect vector (*Leptopharsa gibbicarina*)

Pratique agricole — *Conseils – 349*

Agricultural Practice — *Advice*

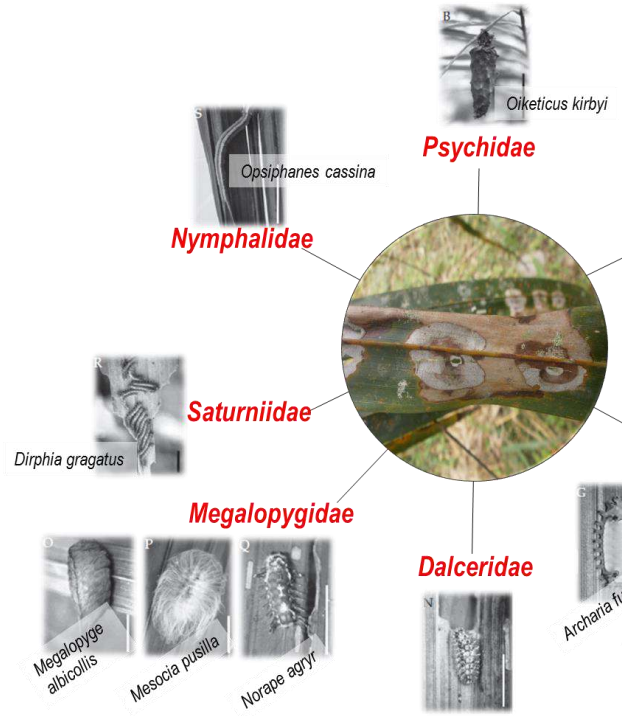
Práctica Agrícola — *Consejos*

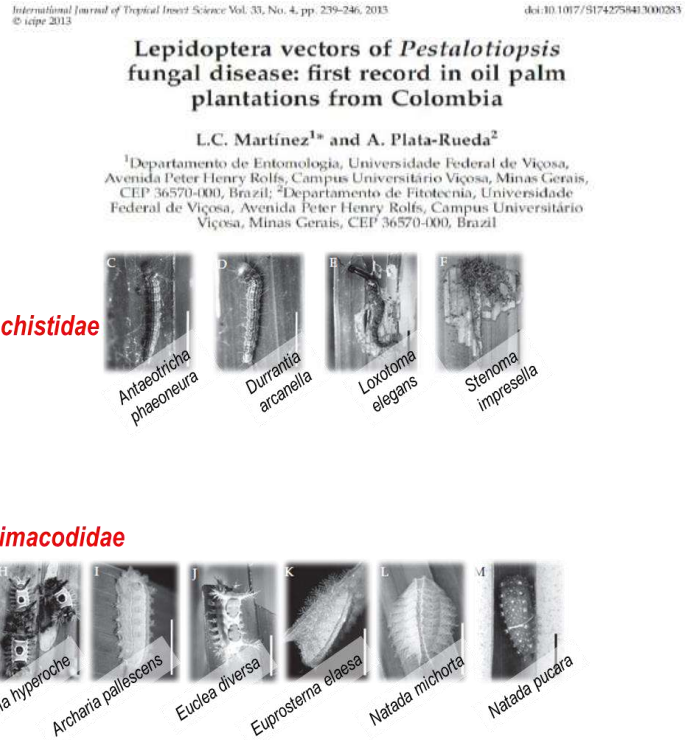
Méthodes de lutte contre le complexe punaises-*Pestalotiopsis* sur le palmier à huile en Amérique latine

190 Oléagineux, Vol. 49, n° 4 - Avril 1994

FIG. 1. — Adultes de *Leptopharsa* (gauche) et *Pycnoderes* (droite) — (Adult *Leptopharsa* left and *Pycnoderes* right) — Adultes *Leptopharsa* (izquierda) y *Pycnoderes* (derecha).

Lepidoptera insect vectors





International Journal of Tropical Insect Science Vol. 33, No. 4, pp. 239–246, 2013 doi:10.1017/S1742758413000283
© icipe 2013

Lepidoptera vectors of *Pestalotiopsis* fungal disease: first record in oil palm plantations from Colombia

L.C. Martínez[1]* and A. Plata-Rueda[2]

[1]Departamento de Entomologia, Universidade Federal de Viçosa, Avenida Peter Henry Rolfs, Campus Universitário Viçosa, Minas Gerais, CEP 36570-000, Brazil; [2]Departamento de Fitotecnia, Universidade Federal de Viçosa, Avenida Peter Henry Rolfs, Campus Universitário Viçosa, Minas Gerais, CEP 36570-000, Brazil

PESTALOTIOPSIS LEAF SPOT DISEASE in LATIN AMERICA

Symptoms:
Appearance of brown spots with yellowish haloes which quickly turn brown and necrosis spreads over the leaf parenchyma

Pathogen(s):

- ***Pestalotiopsis palmarum*** (Labarca *et al*., 2006)
- Escalante *et al*., (2010) reported that the disease was attributed to a **fungal complex involving *P. palmarum, P. glandicula, Colletotrichum, Curvularia, Gloesporium*** **and *Helminthosporium.***

Insect vectors (Lepidoptera insect vectors and Hemiptera (*Leptopharsa gibbicarina*). Disease severity of *Pestalotiopsis* damage increased in the presence of pest outbreaks.

Impact on FFB yields:

- Infection can cause defoliation of the canopy and in severe cases can spread to the upper canopy.
- Under such severe conditions, yield reductions from 30 to 5 tonnes FFB/ha/yr over a 4-year period were reported, reviewed by Martínez & Plata-Rueda (2013).

PESTALOTIOPSIS LEAF SPOT DISEASE in LATIN AMERICA

Symptoms:
Appearance of brown spots with yellowish haloes which quickly turn brown and necrosis spreads over the leaf parenchyma

Pathogen(s):

- ***Pestalotiopsis palmarum*** (Labarca *et al*., 2006)
- Escalante *et al*., (2010) reported that the disease was attributed to a **fungal complex involving *P. palmarum, P. glandicula, Colletotrichum, Curvularia, Gloesporium*** **and *Helminthosporium.***

Insect vectors (Lepidoptera insect vectors and Hemiptera (*Leptopharsa gibbicarina*). Disease severity of *Pestalotiopsis* damage increased in the presence of pest outbreaks.

Control measures:


Oléagineux, Vol. 49, n° 4 - Avril 1994 193

Control methods against the bug-Pestalotiopsis complex on oil palm in Latin America

"Chemical treatments have to be used against the insects rather than against the pathogen"

- Imidacloprid ± B. T ± Beuveria
- Monocrotophos via trunk injection.

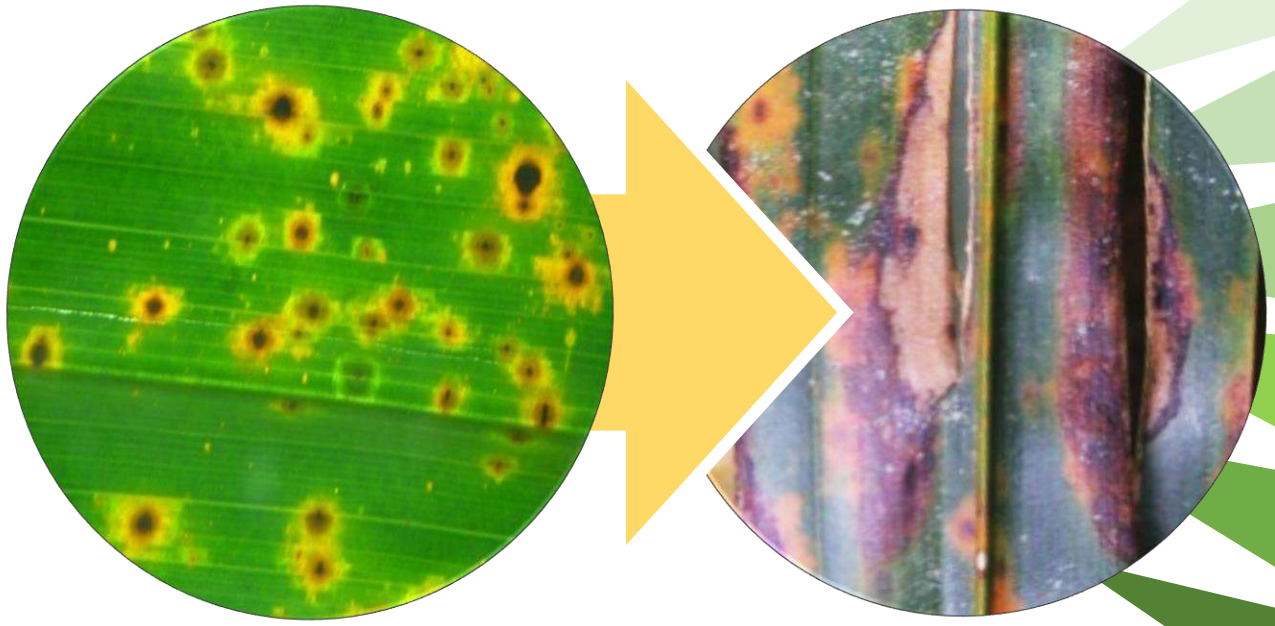
From our own trials testing methamidophos, monocrotophos, dimehypo and acephate distribution in oil palm fronds, chemical distribution is lower in older fronds and also affected by trunk height.

Impact on FFB yields:

- Infection can cause defoliation of the canopy and in severe cases can spread to the upper canopy.
- Under such severe conditions, yield reductions from 30 to 5 tonnes FFB/ha/yr over a 4-year period were reported, reviewed by Martínez & Plata-Rueda (2013).

LEAF SPOT DISEASE OF OIL PALM IN SOUTHEAST ASIA

Symptoms in Southeast Asia

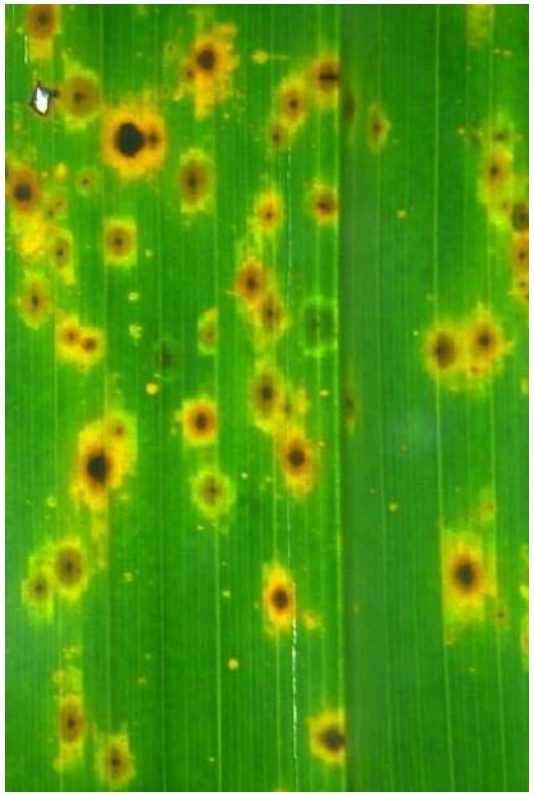


- Symptoms
- Epidemiology
- Pathogen
- Control measures
- Effect on growth and FFB yields
- On-going research

LEAF SPOT DISEASE OF OIL PALM IN SOUTHEAST ASIA

INTRODUCTION

- Leaf spot diseases is **not a fatal disease** of Oil Palm.
- In Southeast Asia, the incidence of leaf spot disease has risen in the last decade.
- It was only in the mid-2000s that AAR started observing its rising incidence, notably worse off in the Southern states of Malaysia, and now commonly sighted throughout East and West Malaysia, Indonesia and reported as well in Thailand and China.



LEAF SPOT DISEASE in MALAYSIA:

SYMPTOM DESCRIPTION

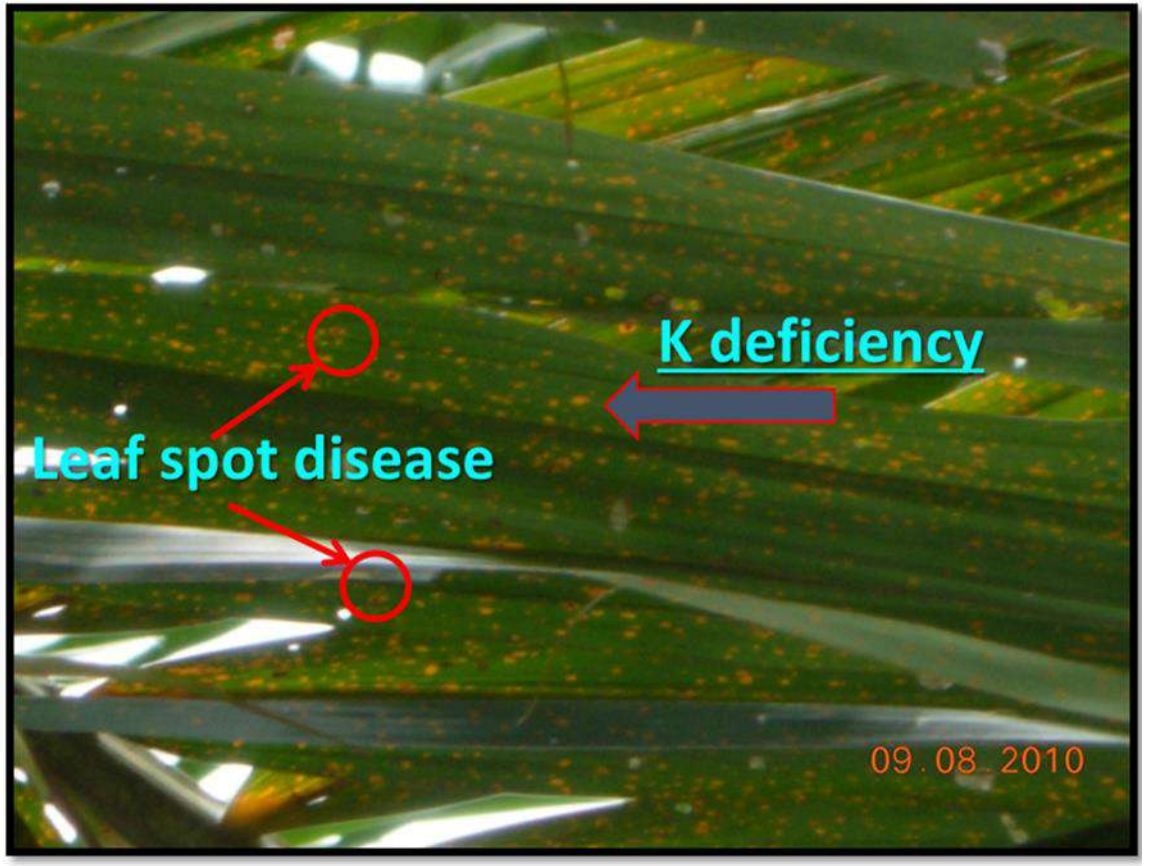
Early symptoms:

- Translucent **circular and eliptical orange spots** with light brown to dark **brown sunken centre** in the centre of the lesion.
- The orange to **yellow halo** is only obvious against a light source otherwise appears as dark orange spots.

- Easily **mistaken for K-deficiency spotting**

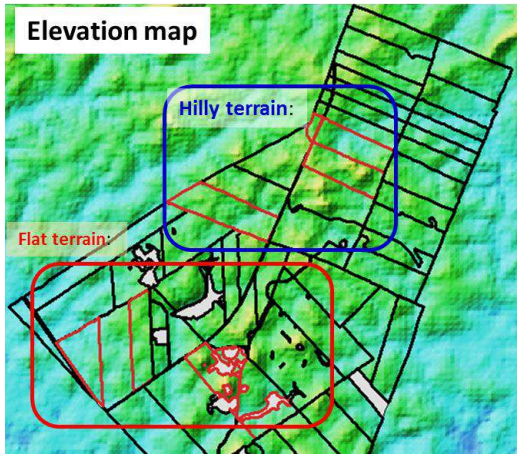
Advanced stage symptoms:

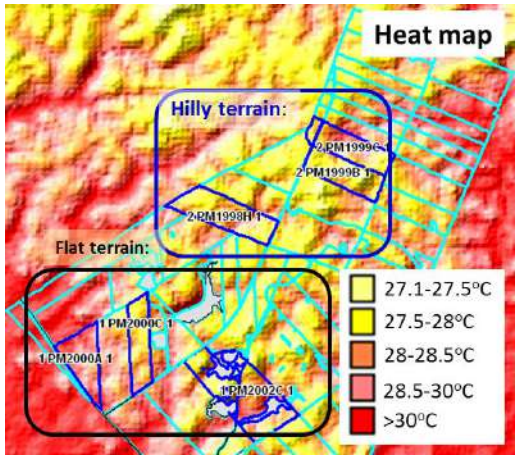
- Severity/number of leaf **spots increases with older fronds**.
- Localised spots coalesce leading to necrotic lesions which eventually die and become dry and brittle.



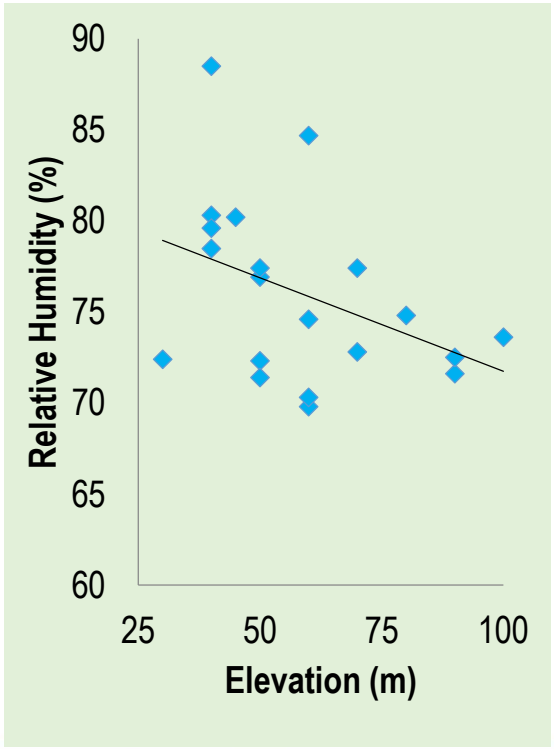
PESTALOTIOPSIS LEAF SPOT DISEASE in MALAYSIA:

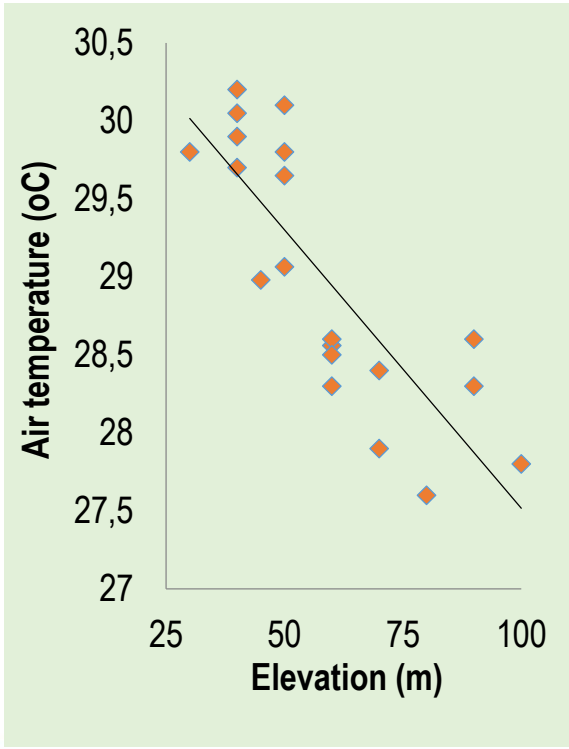
EPIDEMIOLOGY

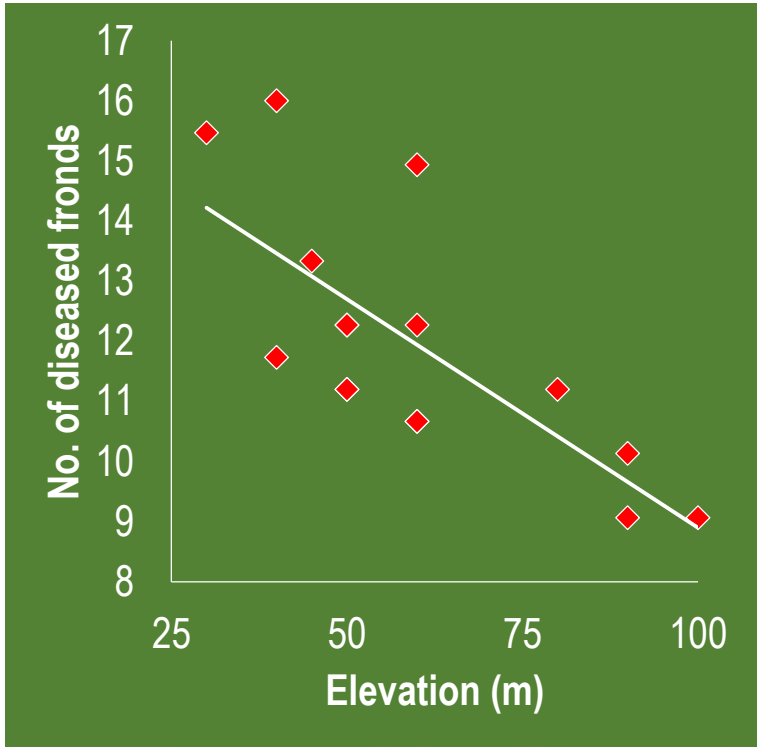




- Survey of 6 blocks reveal a **correlation between elevation and severity** of disease.
  - **Higher terrain has LOWER disease incidence.**
  - **Lower/flat terrain has HIGHER disease incidence.**
- The main factors are likely (1) below canopy **HUMIDITY** and (2) below canopy **TEMPERATURE** which varied with terrain.







OIL PALM LEAF SPOT DISEASE in MALAYSIA:

SEARCHING FOR THE PATHOGEN

Thailand: P. theae

J Gen Plant Pathol (2013) 79:277–279
DOI 10.1007/s10327-013-0453-7

DISEASE NOTE

First report of leaf spot disease on oil palm caused by *Pestalotiopsis theae* in Thailand

Nakarin Suwannarach · Kanaporn Sujarit · Jaturong Kumla · Boonsom Bussaban · Saisamorn Lumyong

China: P. microspora

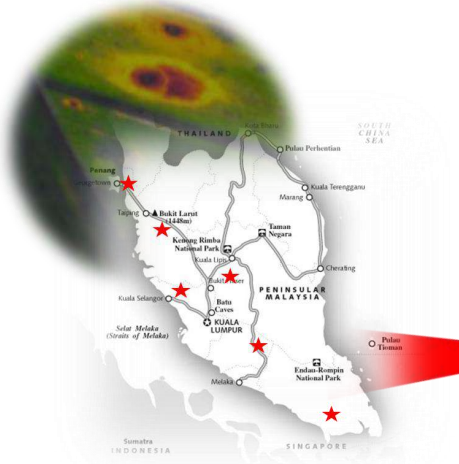
APS Journals — The premier source for peer-reviewed plant pathology research since 1911.

October 2014, Volume 98, Number 10
Page 1429
https://doi.org/10.1094/PDIS-02-14-0163-PDN

Disease Notes

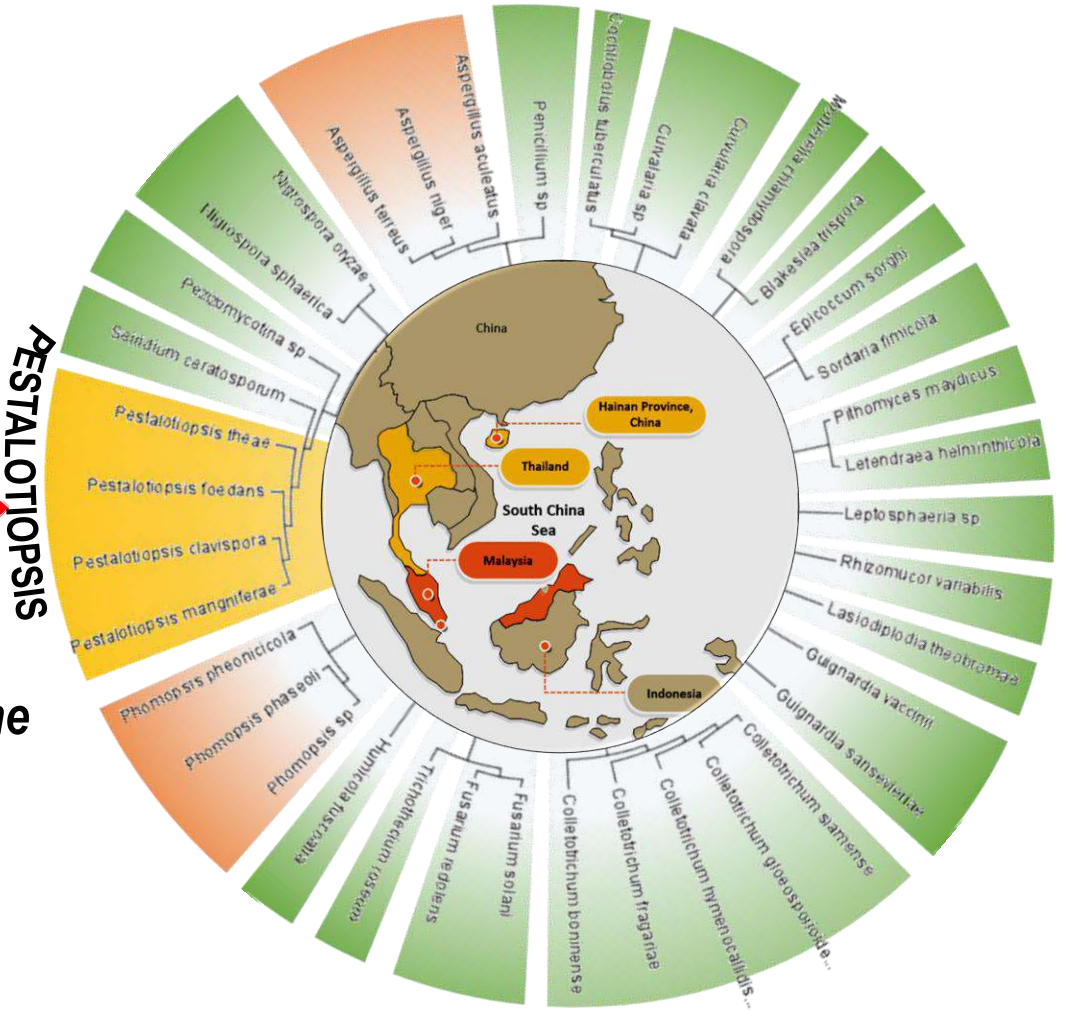
First Report of *Pestalotiopsis microspora* Causing Leaf Spot of Oil Palm (*Elaeis guineensis*) in China

H. F. Shen, **J. X. Zhang**, **B. R. Lin**, and **X. M. Pu**, Plant Protection Research Institute, Guangdong Academy of Agricultural Sciences, Guangdong Provincial Key Laboratory of High Technology for Plant Protection, Guangzhou 510640, China; **L. Zheng**, **X. D. Qin**,



Malaysia?

Is the pathogen the same as Thailand or China?



PESTALOTIOPSIS LEAF SPOT DISEASE:

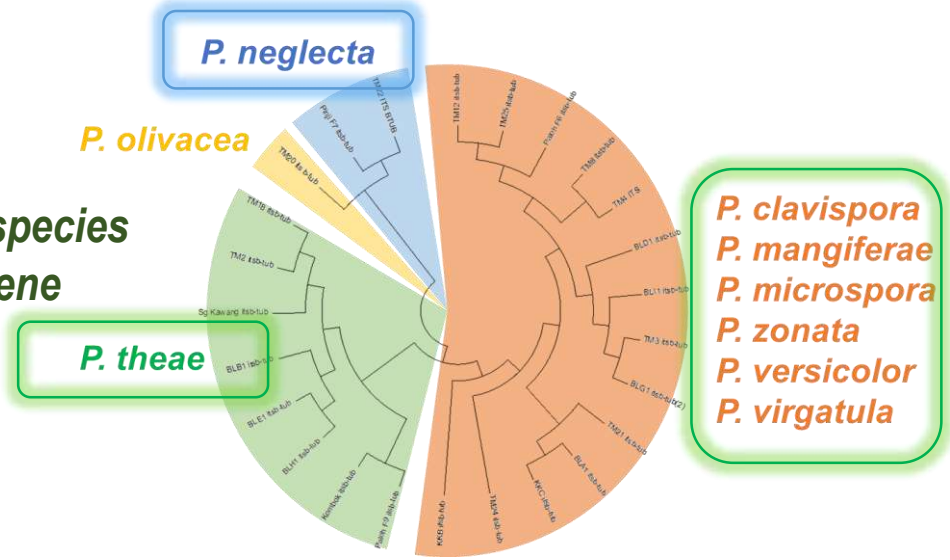
Sorting out Pestalotiopsis taxonomy

- Molecular identification is now commonly used in the identification and classification of *Pestalotiopsis* species but due to its cryptic sequence, i.e. **high sequence homology of the ITS gene, inter-specific delineation is unsuccessful.**
- Taxonomy name is based on the International Code of Nomenclature for algae, fungi and plants but the species named has **in the past been named according to their host associations**, e.g. P. ***mangiferae*** named after the host ***Mangifera*** *indica* (mango).

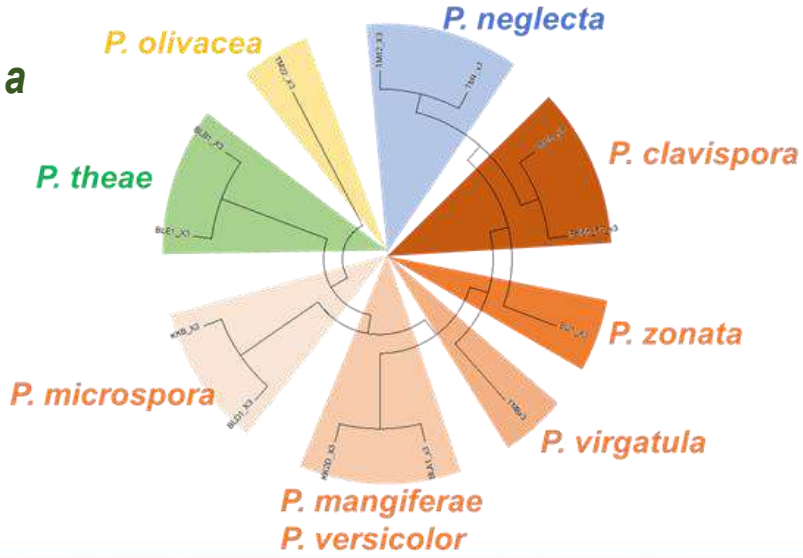
- To further resolve taxonomic issues, a combined dataset DNA sequence comprising ITS, β-tubulin and *tef*1 gene is recommended, i.e. via a multi-loci approach.

99% similarity to *P. palmarum*
100% similarity to *P. neglecta*

Phylogenetic analysis and species designation based on ITS gene



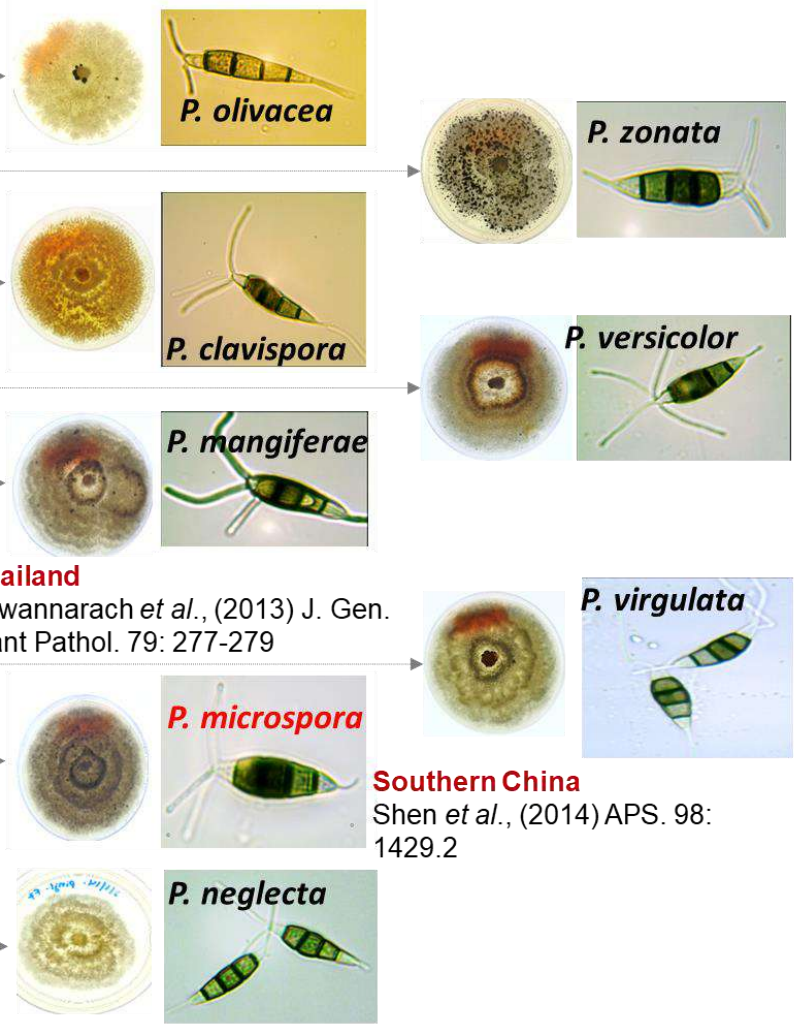
Phylogenetic analysis and species designation based on a multi-loci approach (ITS, β - tubulin and tef1)



PESTALOTIOPSIS DIVERSITY IN OIL PALMS ISOLATED FROM DIFFERENT STATES ACROSS MALAYSIA

Isolation was carried out from diseased lesions of infected oil palm pinnae as well as asymptomatic or healthy tissues.

Isolation resulted in several Pestalotiopsis species with distinct morphometric characteristics. **So, which are pathogenic?**



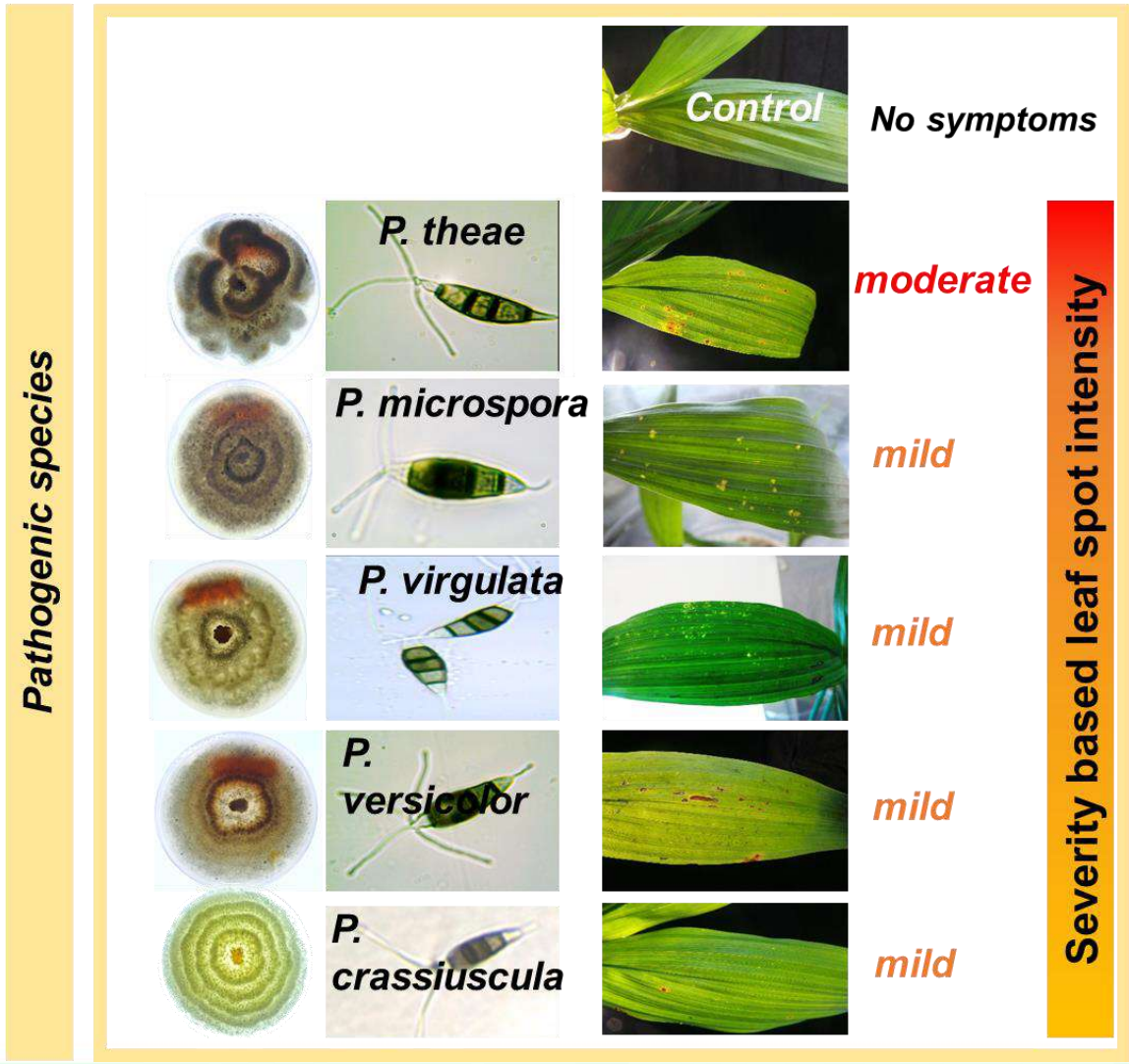
CONFIRMING PATHOGENICITY OF *PESTALOTIOPSIS ISOLATES/SPECIES*

- 3-month old oil palm plantlets were transplanted in sealed plastic containers with acid-washed sand culture.
- Infection can only be induced under humid conditions (55-60% RH) while temperature maintained at 28°C (daylight conditions) and reduced to 22-24°C (dark conditions).
- Each treatment comprises 5 replicates with 6 plants/replicate.
- Infection was observed over a period of 2-3 weeks.

Symptoms of leaf spotting observed while re-isolation of the inoculant was successful.

Symptom differed from leaf spot disease symptoms observed in the field

Non-pathogenic species: • *P. olivacea* • *P. clavispora* • *P. mangiferae* • *P. neglecta* • *P. zonata*

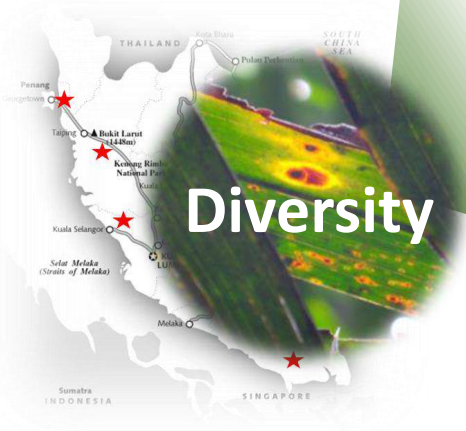


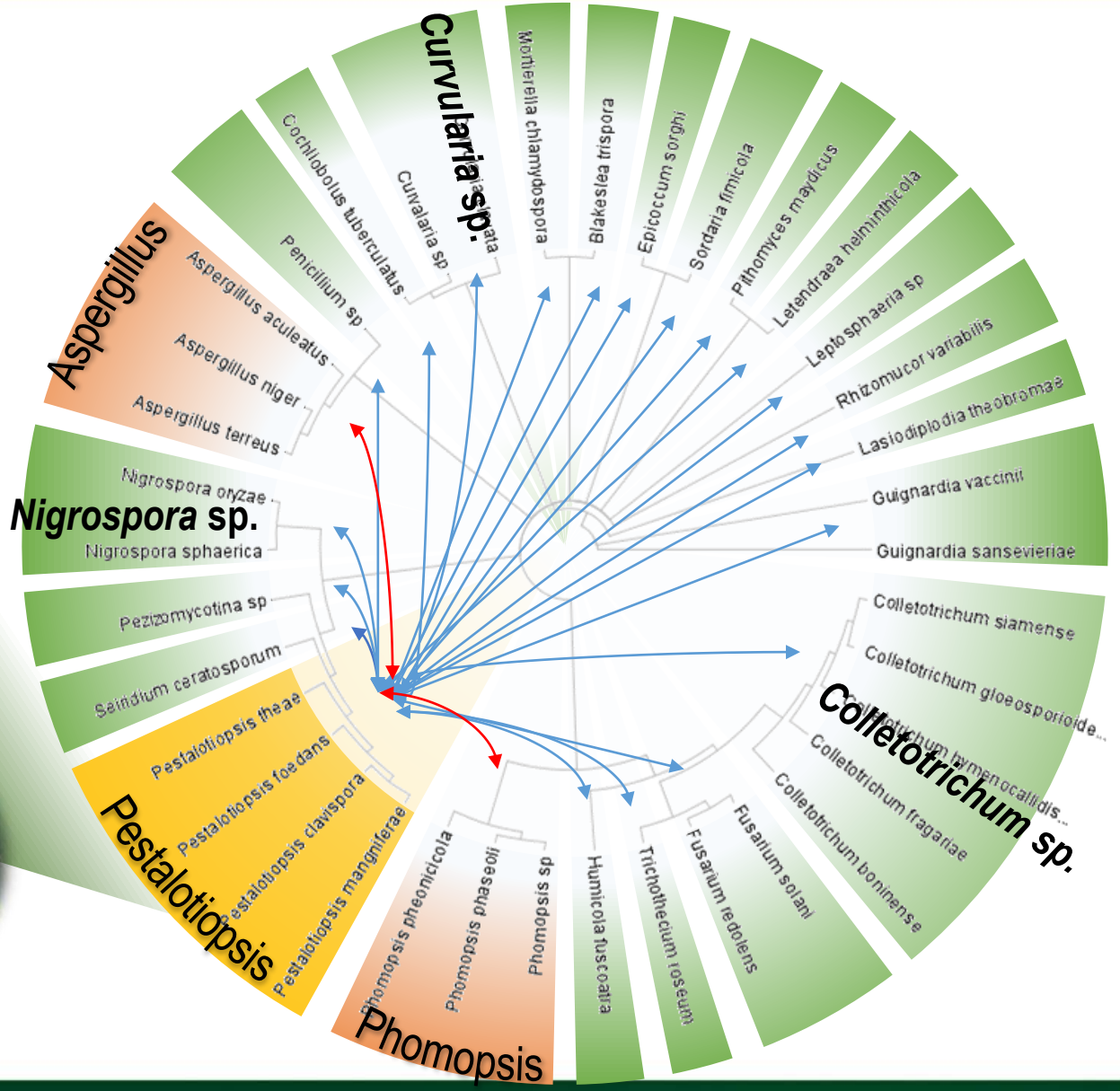
OIL PALM LEAF SPOT DISEASE in MALAYSIA: *IDENTIFYING THE PATHOGEN*

In addition to several different *Pestalotiopsis* species isolated from necrotic disease tissue lesions, **other fungi were also isolated which included pathogenic fungi (*Curvularia* sp., *Colletotrichum sp. and Nigrospora* sp.).** However, these were occasionally isolated.

- Commonly isolated together with *Pestalotiopsis*
- *Occasionally isolated*
- *Pestalotiopsis*

***Aspergillus* sp.** and ***Phomopsis* sp. were commonly isolated together with *Pestalotiopsis* sp.**





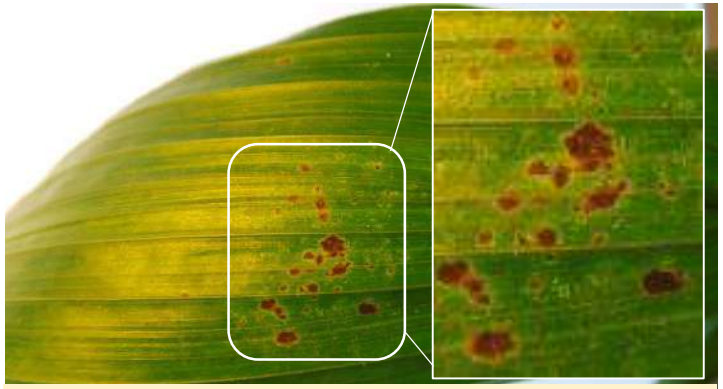
OIL PALM LEAF SPOT DISEASE in MALAYSIA:

IDENTIFYING THE PATHOGEN

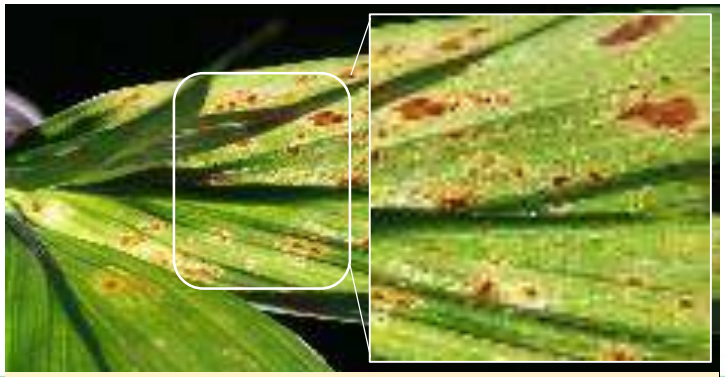
- Co-inoculation with other fungal isolates commonly isolated from leaf spot disease pinnae tissues produced more severe symptoms which resembled more closely with field symptoms.
- Inoculation with individual species (*Phomopsis* sp. and *Aspergillus* sp.) did not induce leaf spot disease symptoms.
- All inoculants were re-isolated and thus complying with Koch's postulates.

- Hence, we have associated leaf spot disease symptoms to be attributed to **interspecies or complexes of interacting pathogenic fungi involving *Pestalotiopsis* species (*P. theae, P. microspora, P. virgulata, P. versicolor* and *P. crassiuscula*), *Aspergillus* sp. and *Phomopsis* sp.**

Control



Inoculated with *P. theae*



Inoculated with *P. theae* + *Phomopsis sp.* + *Aspergillus sp.*

PESTALOTIOPSIS LEAF SPOT DISEASE of OIL PALM in MALAYSIA:

CONTROL MEASURES

- Semi-commercial fungicide trial on 2002 planting (9 year old DxP palms on Rengam/Beserah soil series; *Tipik Lutualemkuts*)
- 3 replicates per treatment.
- 200-250 palms per replicate
- LSD census: *n*=80 palms per replicate/lote
- Dosage as per the manufacturer's recommendation for oil palm

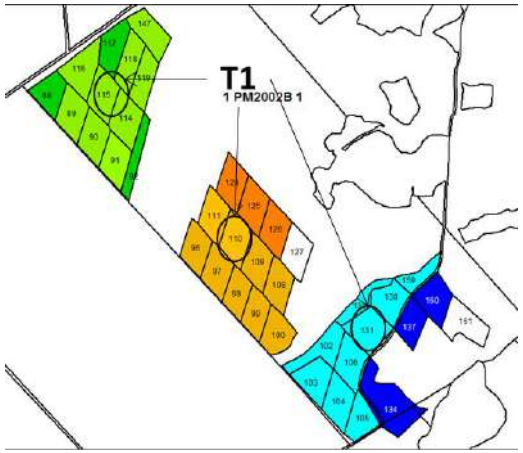
Treat. No.	Active Ingredient	Cost/Ha (RM)
T1	Control	
T2 *	Benzimidazole	28.56
T3 *	Carbendazim	39.17
T4 #	Thiram	42.43
T5 #	Cu oxychloride	78.09
T6 #	Propineb	88.13
T7 #	Metiram	33.05
T8 ##	Chlorathalonil	35.20
T9 #	Epoxiconazole	251.34

* Contact fungicides

\# Systemic fungicides

Partially systemic fungicides

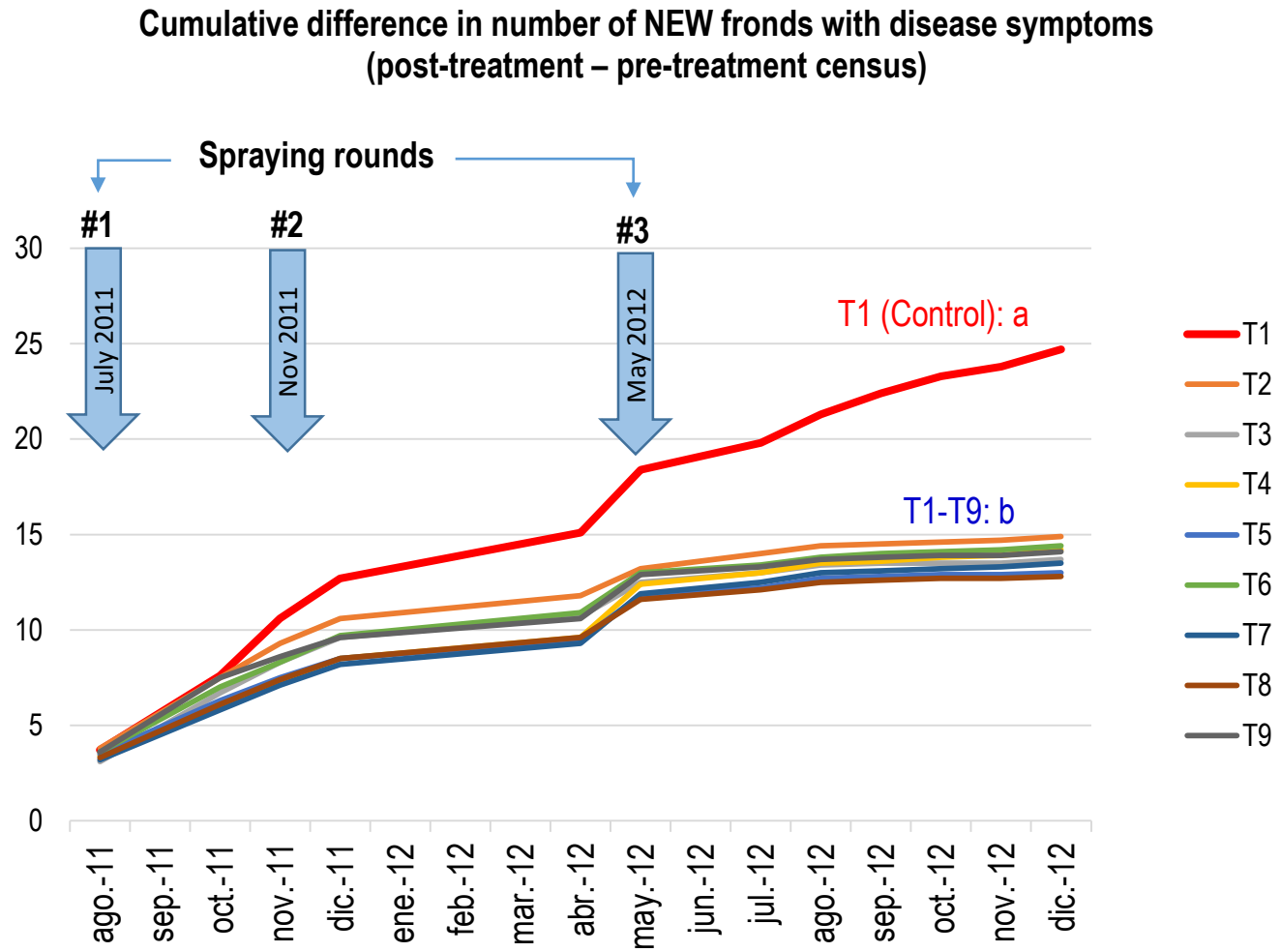
1 USD = RM4.15



PESTALOTIOPSIS LEAF SPOT DISEASE of OIL PALM in MALAYSIA:

CONTROL MEASURES

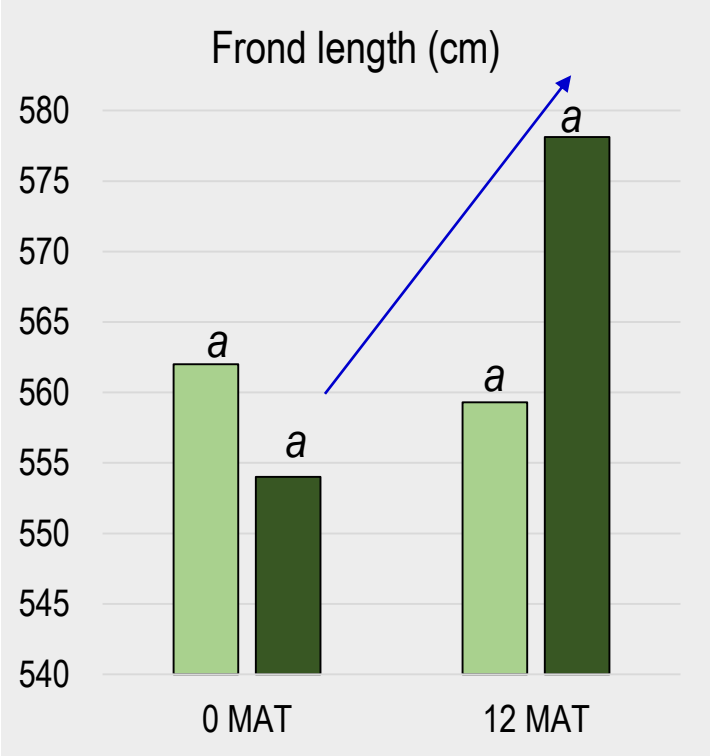
- All fungicides were capable of lowering disease incidence.
- The effective duration of each fungicide application round increased with each application:
  - 1st application: $p>0.05$
  - 2nd application: $p<0.05$ with 4-5 months effective control duration
  - 3rd application: $p<0.05$ with 7 months effective control duration

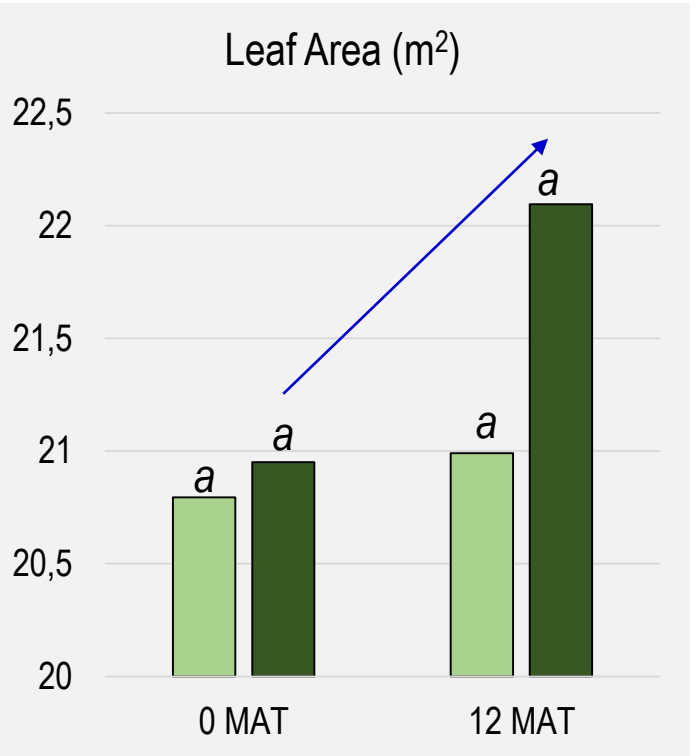


PESTALOTIOPSIS LEAF SPOT DISEASE of OIL PALM in MALAYSIA:

IMPACT ON OIL PALM GROWTH AND FFB YIELDS

- VGM was carried out at 0 and 12 MAT. 10% of palms within each plot were selected for VGM measurements.
- Fungicide treated palms which exhibited a reduction in disease incidences ($p<0.05$) had higher VGM values.





Control and untreated plots (n=3 replicates; $\bar{x}$ = 25 palms per rep)

Fungicide treated plots (n=3 replicates; $\bar{x}$= 25 palms per rep)

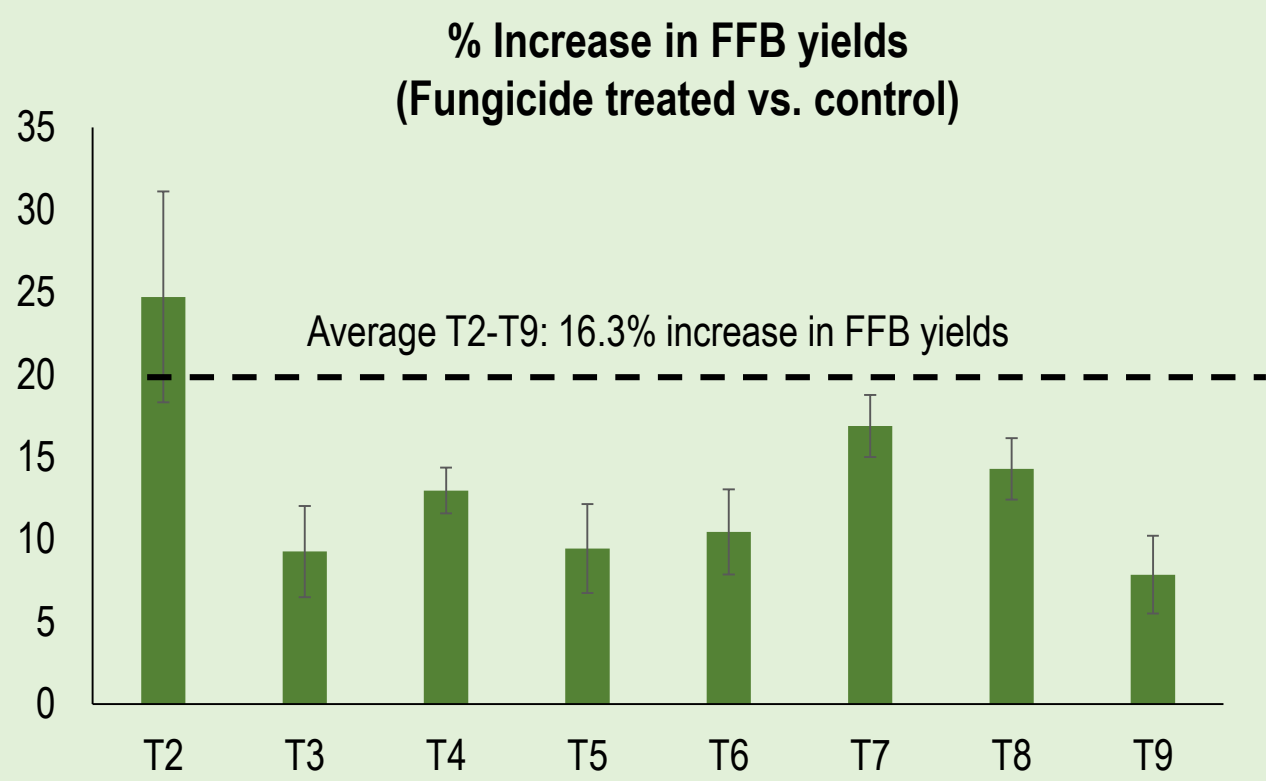
PESTALOTIOPSIS LEAF SPOT DISEASE of OIL PALM in MALAYSIA:

IMPACT ON OIL PALM GROWTH AND FFB YIELDS

- Fungicide treated palms had higher FFB yields compared to the untreated control plot. FFB yield difference between treated and control plots ranged from 7.8-24.7%, averaging at 16.3%.

- Fungicide treated palms which exhibited a reduction in disease incidences ($p<0.05$) had higher VGM values as well as higher FFB yields, indicative that if left untreated, severe leaf spot disease reduce oil palm VGM and FFB productivity, attributed to:

  a. Reduction in photosynthesizing leaf tissue.
  b. Reduction in total carbohydrate content in control vs. fungicide treated palms.

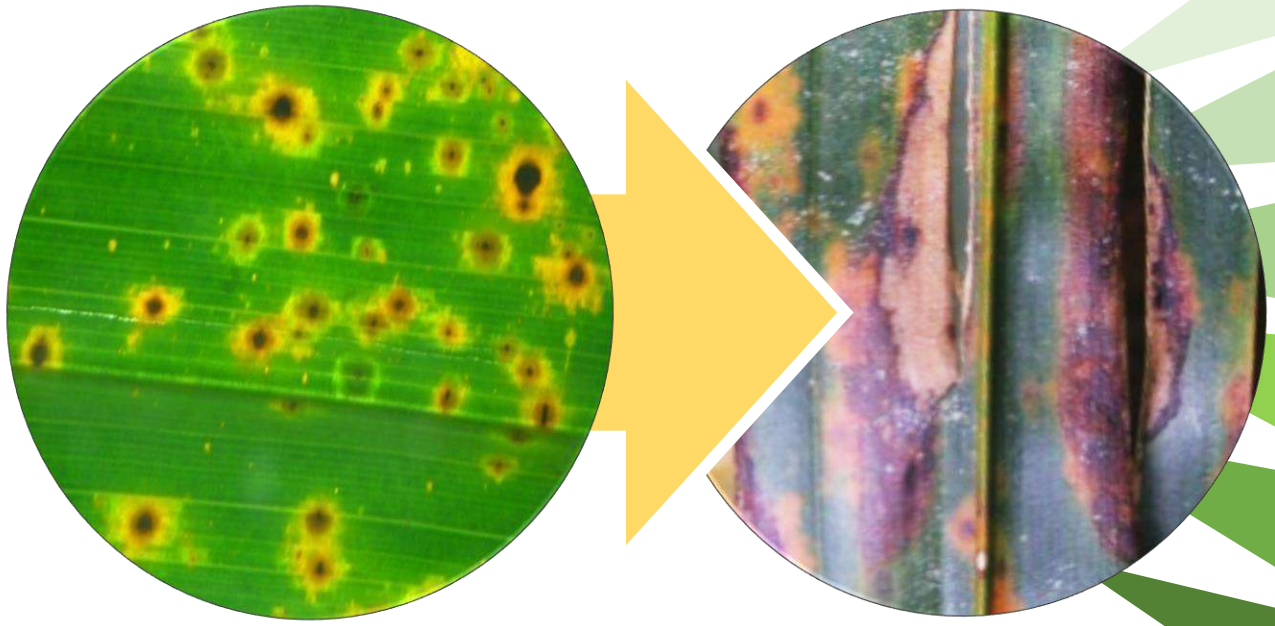


Control / untreated plots (n=3 replicates; $\bar{x}$ = 247 palms per rep)

Fungicide treated plots (n=3 replicates; $\bar{x}$= 247 palms per rep)

LEAF SPOT DISEASE OF OIL PALM IN SOUTHEAST ASIA

Symptoms in Southeast Asia



- Symptoms
- Epidemiology
- Pathogen
- Control measures
- Effect on growth and FFB yields
- On-going research

PESTALOTIOPSIS LS DISEASE of OIL PALM in MALAYSIA:

ON-GOING RESEARCH

CURATIVE CONTROL MEASURES VIA FUNGICIDES

1. **Screening fungicides reportedly with higher efficacy to control Ascomycete fungal pathogens**

   Objective: By increasing fungicide efficacy, can we reduce spraying rounds?

PREVENTIVE CONTROL MEASURES

1. **Evaluation of Si as a preventive control measure**

   Objective: To identify sustainable measures to treat diseases by reducing agro-chemical usage in oil palm cultivation. Furthermore, fungicides will also affect the natural balance of fungal biodiversity in oil palm which also comprises beneficial fungi.

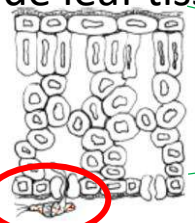
2. **Screening for tolerant planting materials**

   Objective: To identify tolerant materials against leaf spot disease amongst AAR commercial planting materials.

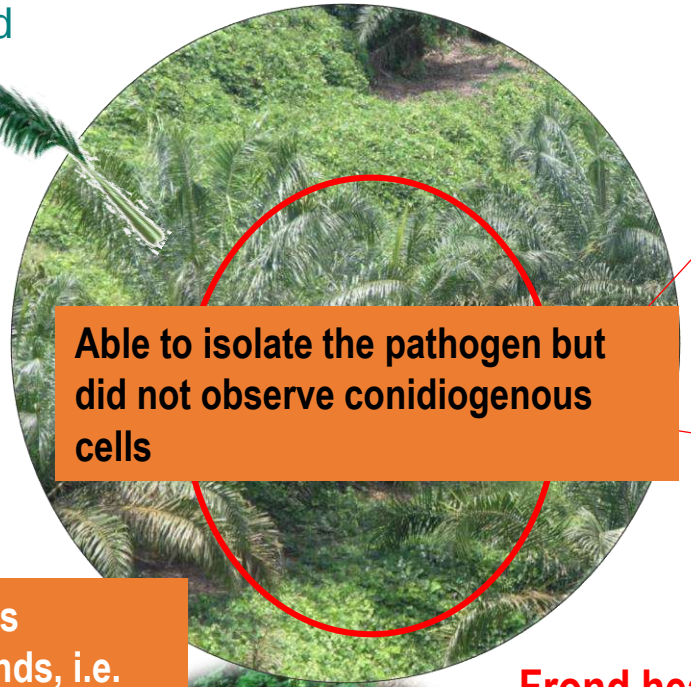
PESTALOTIOPSIS LEAF SPOT DISEASE of OIL PALM in SOUTHEAST ASIA:

LIFE CYCLE

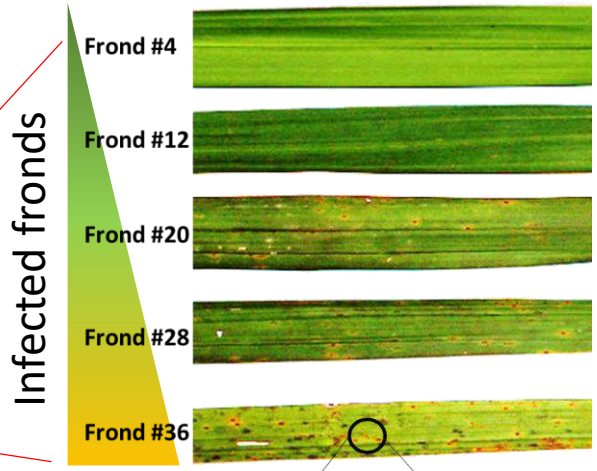
Invade leaf tissue

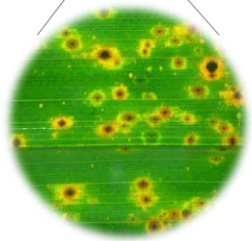


Frond



Able to isolate the pathogen but did not observe conidiogenous cells

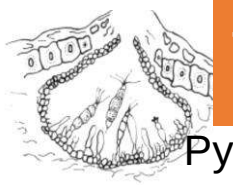




Frond heaps (decomposing fronds)

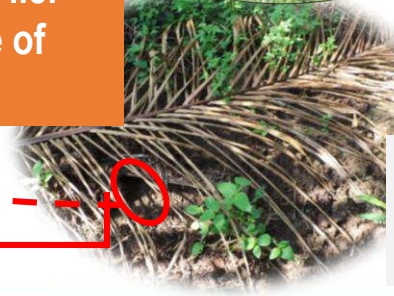
Conidiogenou

Pycnidium and conidiogenous spores was frequently observed on decomposing fronds, i.e. frond heaps which serves as the main source of inoculum.



Pycnidium

Perithecium



- Increase in disease severity with frond age.
- Under severe conditions, infection can lead to lower frond desiccation.

ON-GOING RESEARCH:

1. Screening of fungicides to determine fungicides with higher efficacy to control leaf spot diseases based on their IC_{50} values (Half Maximal Inhibitory Concentration of fungicides (mg/L).
2. DMI fungicides have lower IC50 values and thus capable of inhibiting fungal growth at lower dosages.

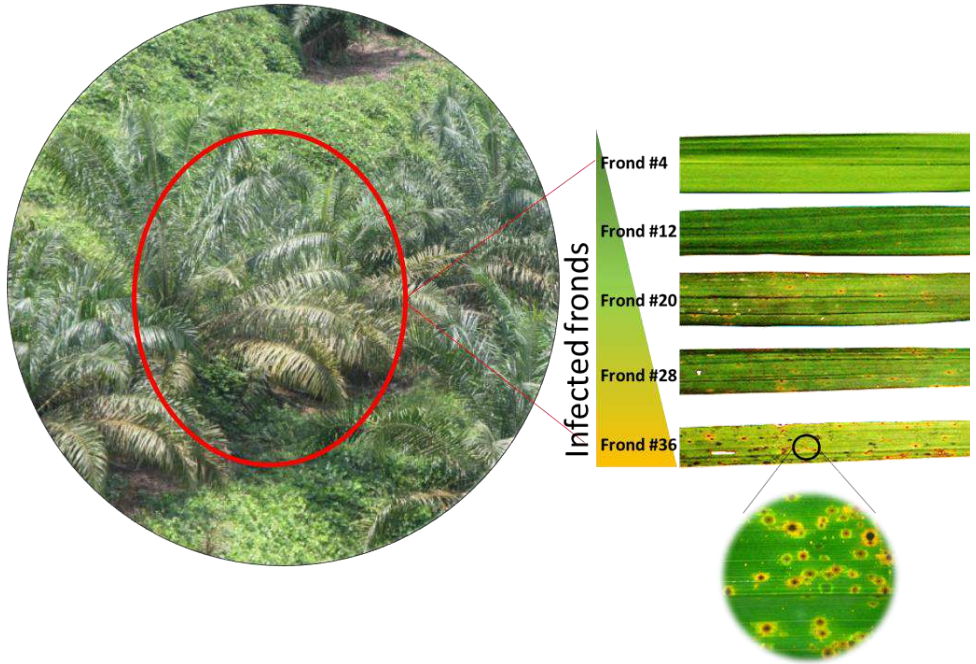
High IC_{50}

Low IC_{50}

	Fungicide	
F1	Thiram	
F2	Pyraclostrobin	QoI
F3	Chlorothalonil	Multi-site/Nitrile
F4	Captan	Contact
F5	Azoxystyrobin	QoI
F6	Difenconazole	DMI
F7	Propiconazole	DMI
F8	Propineb	

Pathogenicity

Frond heaps (decomposing fronds)



QoI – Quinone outside Inhibitor inhibit fungal protein-tyrosine phosphatase
DMI – DeMethylation Inhibitors disrupt fungal sterol/ergosterol biosynthesis

- Fungal inhibition was based on surface area scanning of 16-well plates (pre-filled with PDA ± fungicides via a multi-plate spectrophotometer.
- Pathogenic strains: 5 isolates of *P. theae, P. microspora* and *P. vigulata*
- Inhibition assay on 8 fungicides x 9 concentrations (0-100 ppm) x 5 replicates

PESTALOTIOPSIS LS DISEASE of OIL PALM in MALAYSIA:

ON-GOING RESEARCH

CURATIVE CONTROL MEASURES VIA FUNGICIDES

1. **Screening fungicides reportedly with higher efficacy to control Ascomycete fungal pathogens**

   Objective: By increasing fungicide efficacy, can we reduce spraying rounds?

PREVENTIVE CONTROL MEASURES

1. **Evaluation of Si as a preventive control measure**

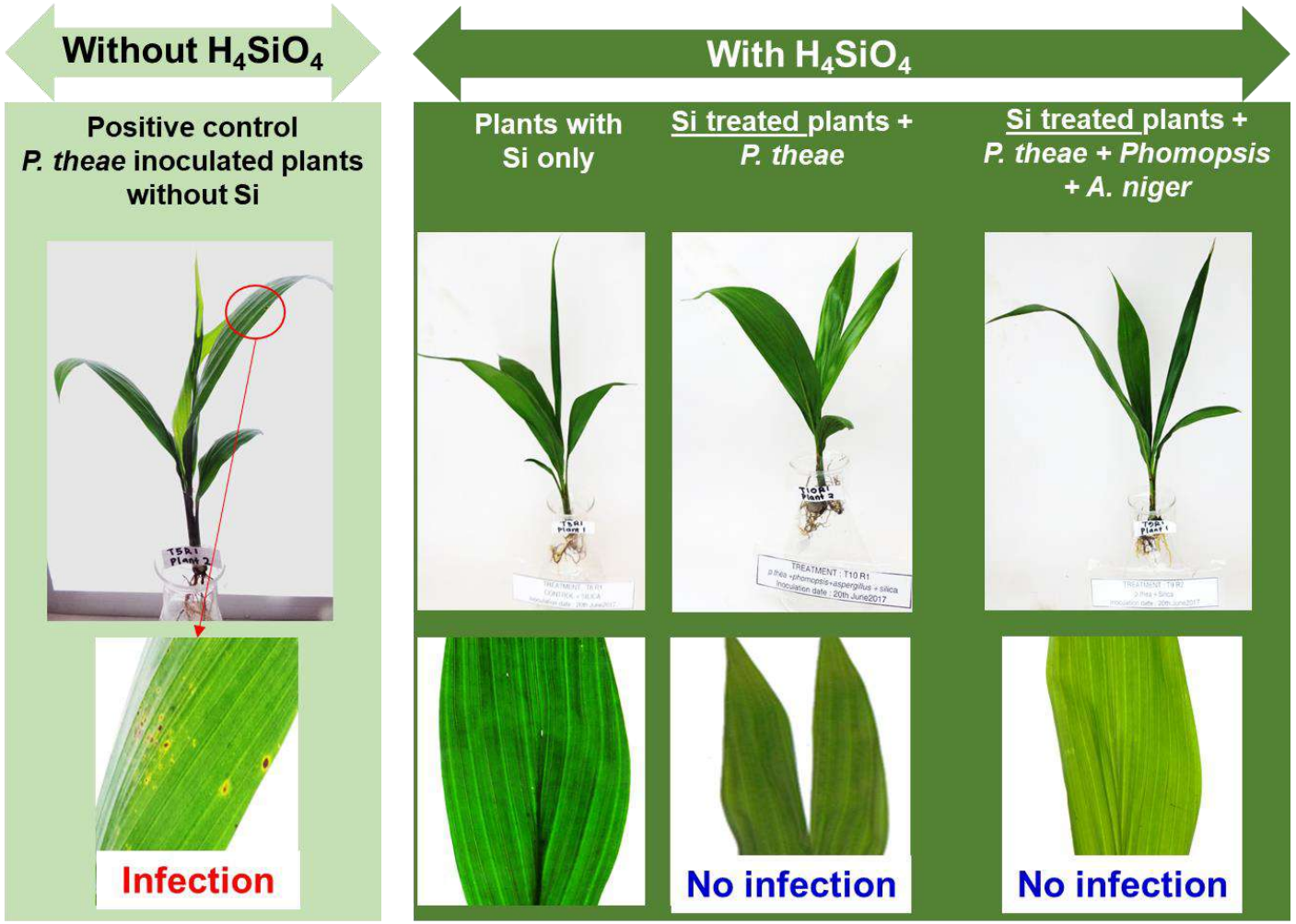
   Objective: To identify sustainable measures to treat diseases by reducing agro-chemical usage in oil palm cultivation. Furthermore, fungicides will also affect the natural balance of fungal biodiversity in oil palm which also comprises beneficial fungi.

2. **Screening for tolerant planting materials**

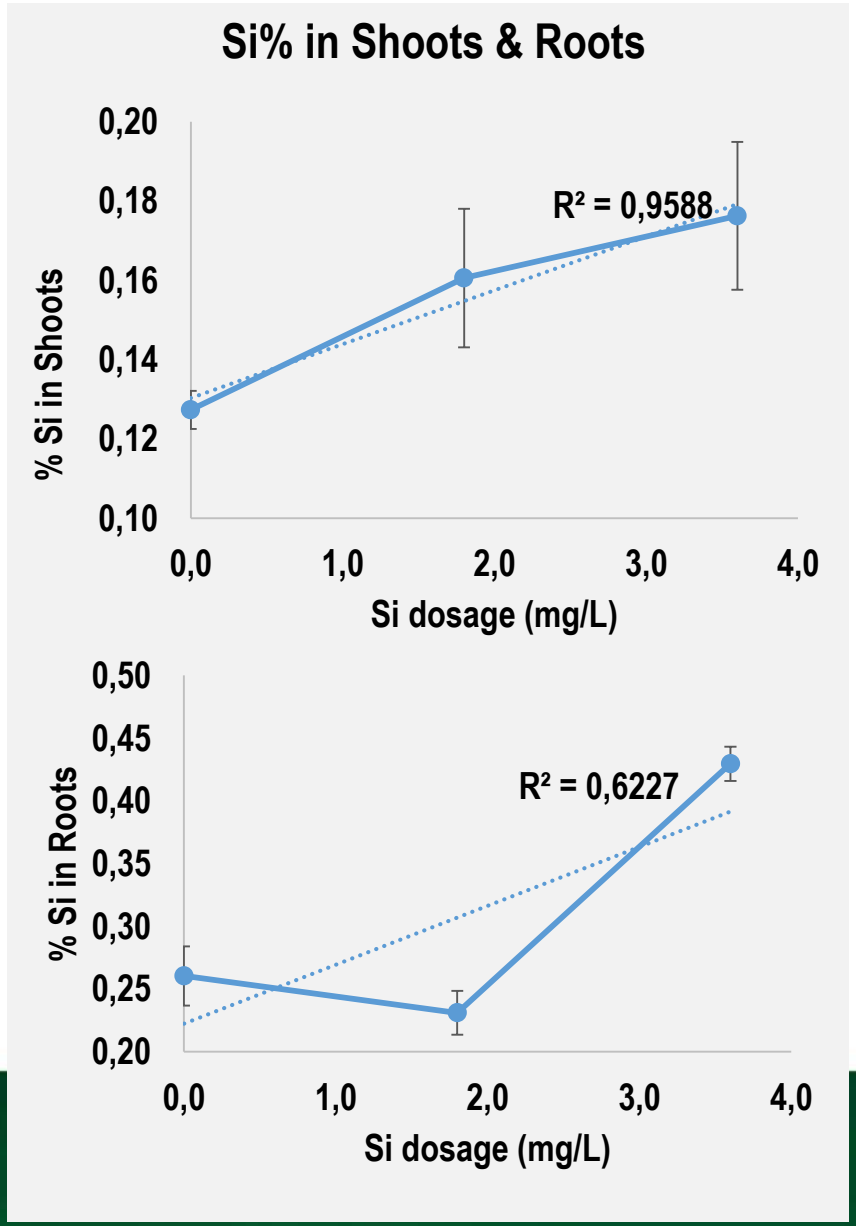
   Objective: To identify tolerant materials against leaf spot disease amongst AAR commercial planting materials.

Effects of Si treatments on Pestalotiopsis leaf spot disease

Plants were treated with Ca/K monosilicic acid (H_4SiO_4) via soil drenching 1 month before infection



Each treatment comprises 4 technical replicates with 8 plants/replicate.



PESTALOTIOPSIS LS DISEASE of OIL PALM in EAST & SOUTHEAST ASIA:

ON-GOING RESEARCH

CURATIVE CONTROL MEASURES VIA FUNGICIDES

1. **Screening fungicides reportedly with higher efficacy to control Ascomycete fungal pathogens**

   Objective: By increasing fungicide efficacy, can we reduce spraying rounds?

PREVENTIVE CONTROL MEASURES

1. **Evaluation of Si as a preventive control measure**

   Objective: To identify sustainable measures to treat diseases by reducing agro-chemical usage in oil palm cultivation. Furthermore, fungicides will also affect the natural balance of fungal biodiversity in oil palm which also comprises beneficial fungi.

2. **Screening for tolerant planting materials**

   Objective: To identify tolerant materials against leaf spot disease amongst AAR commercial planting materials.

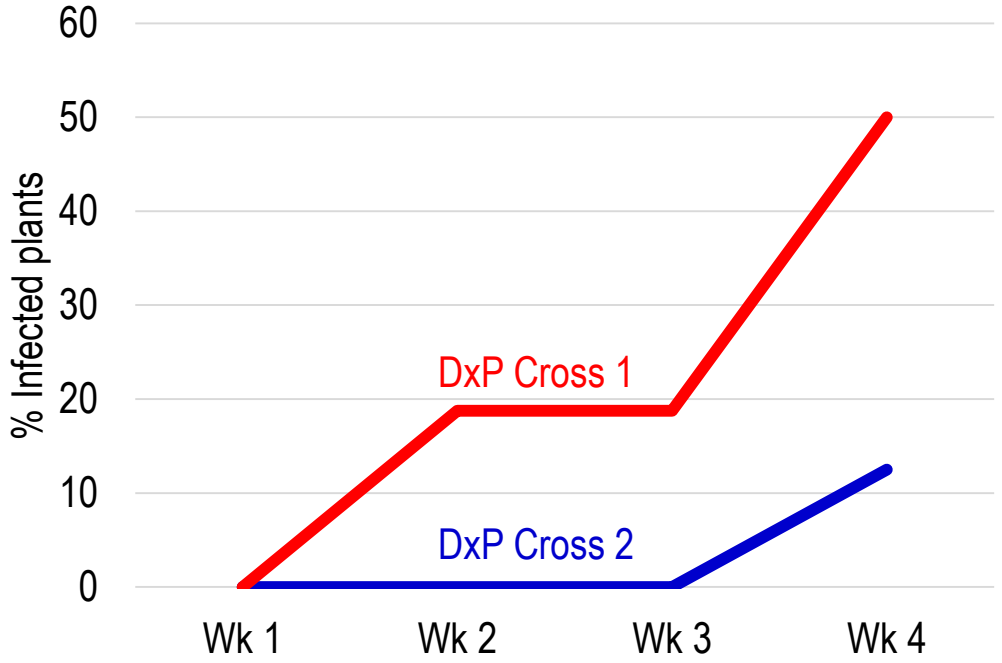
On-going: Screening for tolerant/susceptible planting materials against Pestalotiopsis LSD

From our earlier trials in screening pathogenicity of fungal pathogens, we observed differences in disease severity amongst AAR Commercial planting materials

Crosses	Susceptibility towards Pestalotiopsis LSD (co-inoculated with *Phomopsis* sp. & *Aspergillus* sp.		Post 2 weeks after inoculation
DxP Cross 1	High	+++	
DxP Cross 2	Low	+	

At post 2 weeks after infection/inoculation, early symptoms of disease symptoms observed with DxP Cross 1

Susceptible vs. Tolerant lines amongst AAR Commercial Planting Materials



Each treatment comprises 6 replicates with 8 plants/replicate.

Currently screening planting materials to generate sufficient phenotypic data to correlate with genotyping data.

PESTALOTIOPSIS LS DISEASE of OIL PALM:
Similarities between Latin America and Southeast/East Asia

	Latin America	Southeast Asia
PATHOGEN	**Complex involving primary pathogen**: *P. Palmarum* **and other fungi (***P. glandicula, Colletotrichum, Curvularia, Gloesporium* and *Helminthosporium*).	**Complex involving primary pathogen**: *P. theae, P. microspora, P. virgulata, P. versicolor, P. crassiuscula* **and other fungi** (*Phomopsis* sp. and *Aspergillus* sp.)
VECTOR	*Hemiptera (Leptopharsa) and Lepidoptera insects*	? No direct correlation between disease incidence and vector outbreaks
SYMPTOMS	*Early symptoms appear similar while advance stage is different*	
EPIDEMIOLOGY	Associated with insect vector outbreaks?	Associated with temperature and humidity. Disease incidence appears to increase upon the on-set of canopy closure, influenced by temperature and rainfall.
DISEASE IMPACT	VGM and FFB reduction	VGM and FFB reduction

PESTALOTIOPSIS LS DISEASE of OIL PALM:
Similarities between Latin America and Southeast/East Asia

	Latin America	Southeast Asia
DISEASE IMPACT	VGM and FFB reduction	VGM and FFB reduction
CURATIVE CONTROL MEASURES	Vector control via pesticide Fungicide control?	Pathogen control via fungicides Pesticide control?
PREVENTIVE CONTROL MEASURES		1. Silica can confer tolerance against complex pathogen but remains to be validated under field conditions. 2. Selection of tolerant planting materials.

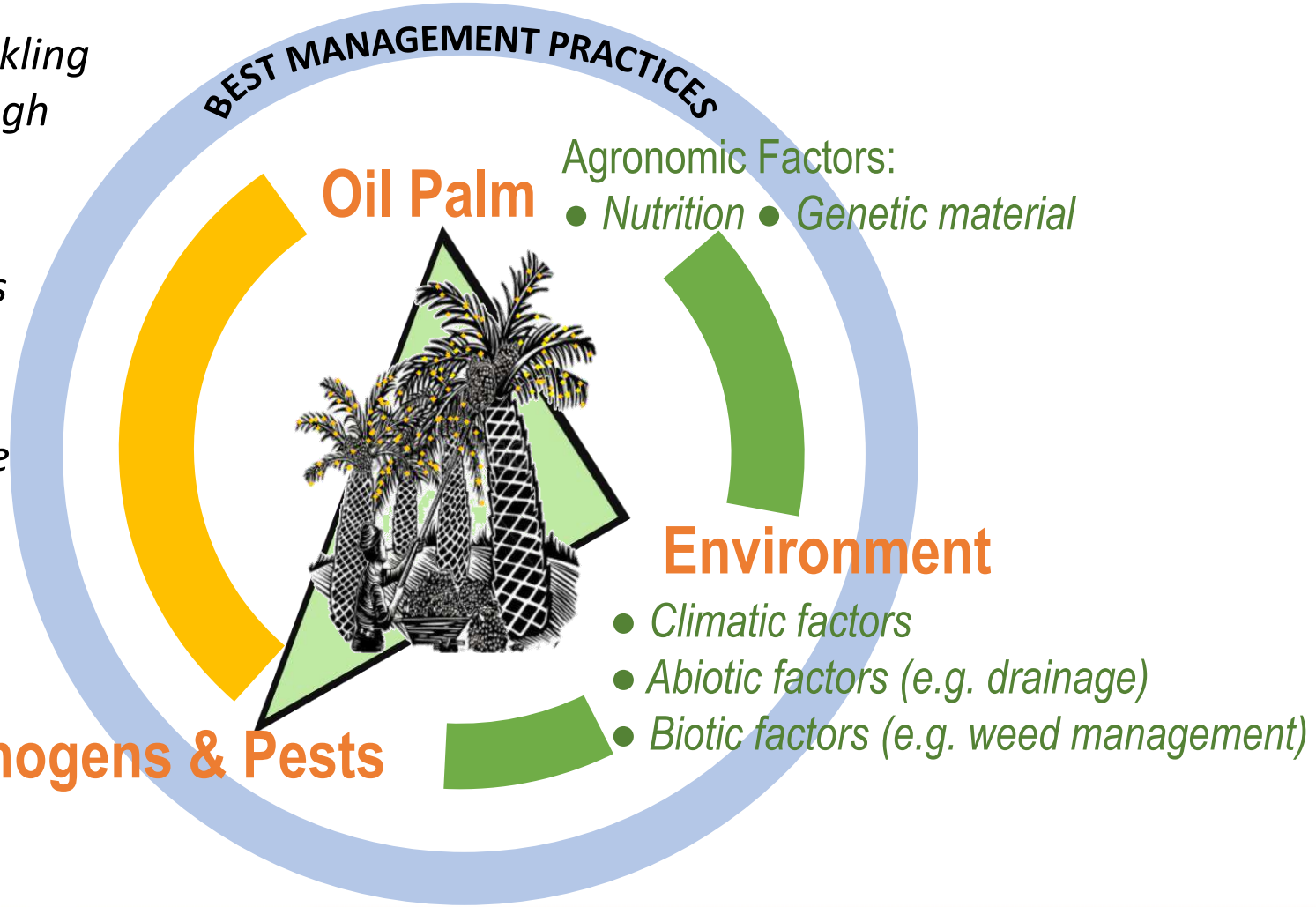
NUTRITION and/or BEST MANAGEMENT PRACTICES ON PESTS AND DISEASES?

INTEGRATED PESTS & DISEASE MANAGEMENT

In many cases, addressing P&D outbreaks are often based on tackling the pests or diseases either through chemical or sanitation measures.

Efforts to control Pests & Diseases should be addressed holistically.

In many cases, P&D outbreaks are associated to Environmental conditions and poor agro-management practices.

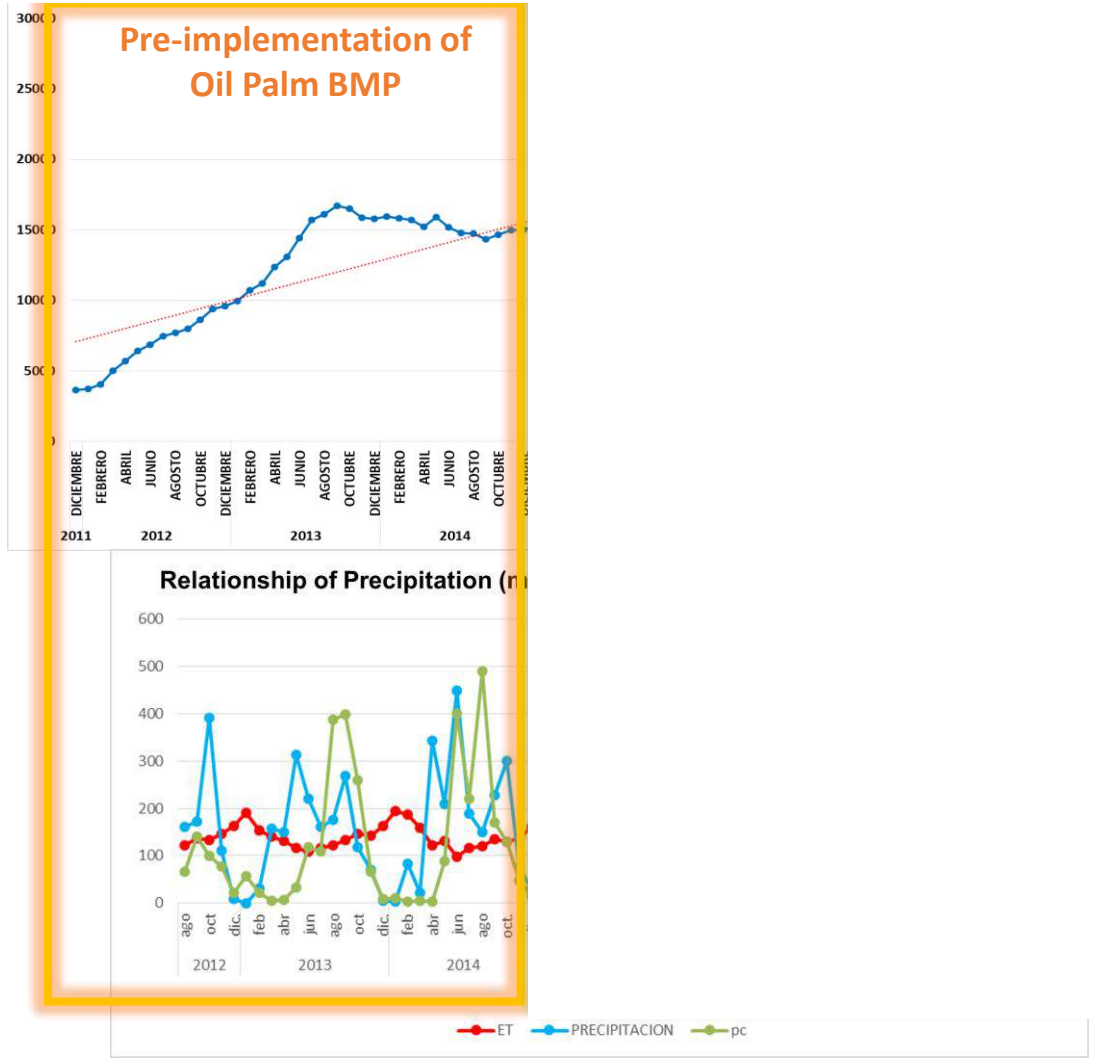


CASE STUDY: IMPLEMENTATION OF OIL PALM BEST MANAGEMENT PRACTICES ON FFB PRODUCTIVITY & DISEASE (BUD ROT) SUPPRESSION AT COROZITO ESTATE

Prior to the implementation of BMP, Corozito estate, despite recording a steady increase in FFB yield, the number of PC/bud rot cases often peaked following a periods of high rainfall.

Subsequent to the implementation of best management practices such as site specific fertilizer recommendations, drainage, soil and moisture conservation measures, weed management and P&D management, FFB yields continued to increase along concurrent with balanced oil palm and soil nutritional levels but importantly began recording lower disease incidences of bud rot (PC) cases.

12- MONTH TOTAL YIELD OF COROZITO



Data courtesy of Corozito & C. Manrique

THANK YOU