Dr. Mohamed Mazmira Mohd Masri

Head, Entomology and Integrated Pest Management Unit, Biology and Sustainability Research Division, Malaysian Palm Oil Board (MPOB)

EDUCATIONAL BACKGROUND

- Doctor of Philosophy (PhD) in Bioprocess Technology (UPM)
- Master of Business Administration (MBA) (GSB, UKM)
- Master of Science (MSc) in Microbiology (UKM)
- Bachelor of Science with Honors (BSc) (UKM)

AREAS OF EXPERTISE AND EXPERIENCE

- Over two decades of professional experience in beneficial microbe research and biological control, with a focus on large-scale biopesticide production.
- Engaged in comprehensive studies related to various oil palm pests, including bagworms, rhinoceros beetles, bunch moth, termites and also on oil palm pollinators.
- Development of IPM system for bagworms and other oil palm pests.
- Implemented advanced technologies, including agricultural aircraft, drones and sensors, to enhance the precision and efficacy of oil palm pest control strategies.

MPOB
soppoa
Seminar on R&D Progress 2023
15 Nov 2023, Bintulu, Sarawak

IPM Strategies for Bagworm Management in Oil Palm: An Update on Current Research and Projects

Mohamed Mazmira bin Mohd. Masri, PhD

Head of Entomology and Integrated Pest Management Unit
Biological and Sustainability Research Division
Malaysian Palm Oil Board

Introduction

- Bagworm is currently a major defoliating pest that attacks oil palm plantations especially in Peninsular Malaysia (> 100,000 ha).
- Bagworms infestation can lead to reduction in oil palm yield by 40% in 2 years.
- Total yield loss due to bagworm exceeded RM 100 million annually

- Over-reliance and constant use of broad-spectrum chemical insecticides to control bagworm outbreaks.
- Non-existence of beneficial plants in the plantation to attract natural enemies (predator and parasitoid)
- Lack of basic knowledge on the implementation of IPM systems and the physiology of the bagworm among the oil palm planters
- Infestation from neighboring plantations
- Reluctance from several oil palm planters to conduct control operations, with a few reasons such as not technically well-equipped, limited knowledge and insufficient funds.

Bagworms can spread through:

Contact through palm leaves

Vehicles and farm machineries

Wind

BAGWORMS

Metisa plana

Pteroma pendula

Mahasena corbetti

Leaf-eating caterpillar concealed in a bag constructed from bit of material from the plant it feeds upon.

Gazetting of bagworm as dangerous pest

Due to MPOB continuous effort in emphasizing the damaging impact of bagworm to the oil palm industry, bagworm has been gazetted as a dangerous pest on 15 November 2013 under the Plant Quarantine Act 1976 (Federal Government Gazette Act 167).

It is an offense under the Plant Quarantine Act 1976 (Act 167) if this dangerous pest is left without control and upon conviction can be penalized not exceeding RM10,000 or imprisonment for a term not exceeding two years or both, as stated under plant Quarantine Act 1976.

15 November 2013
15 November 2013
P.U. (B) 468

WARTA KERAJAAN PERSEKUTUAN

FEDERAL GOVERNMENT GAZETTE

PERISYTIHARAN MAKHLUK PEROSAK BERBAHAYA 2013

DECLARATION OF DANGEROUS PESTS 2013

DISIARKAN OLEH/
PUBLISHED BY
JABATAN PEGUAM NEGARA/
ATTORNEY GENERAL'S CHAMBERS

Integrated Pest Management (IPM) of bagworms

- IPM is an effective & environmentally sensitive approach to pests control.
- IPM program use up-to-date, inclusive information of the life cycles of pests and their interaction with the environment.
- Over reliance on chemical insecticides has led to the following problems:
  - ✓ Resistance of pests
  - ✓ Abundance of chemical residue
  - ✓ Disruption of beneficial insects
- Provides sustainable alternative other than chemical insecticides.
- MPOB has developed an IPM program specific for bagworm.

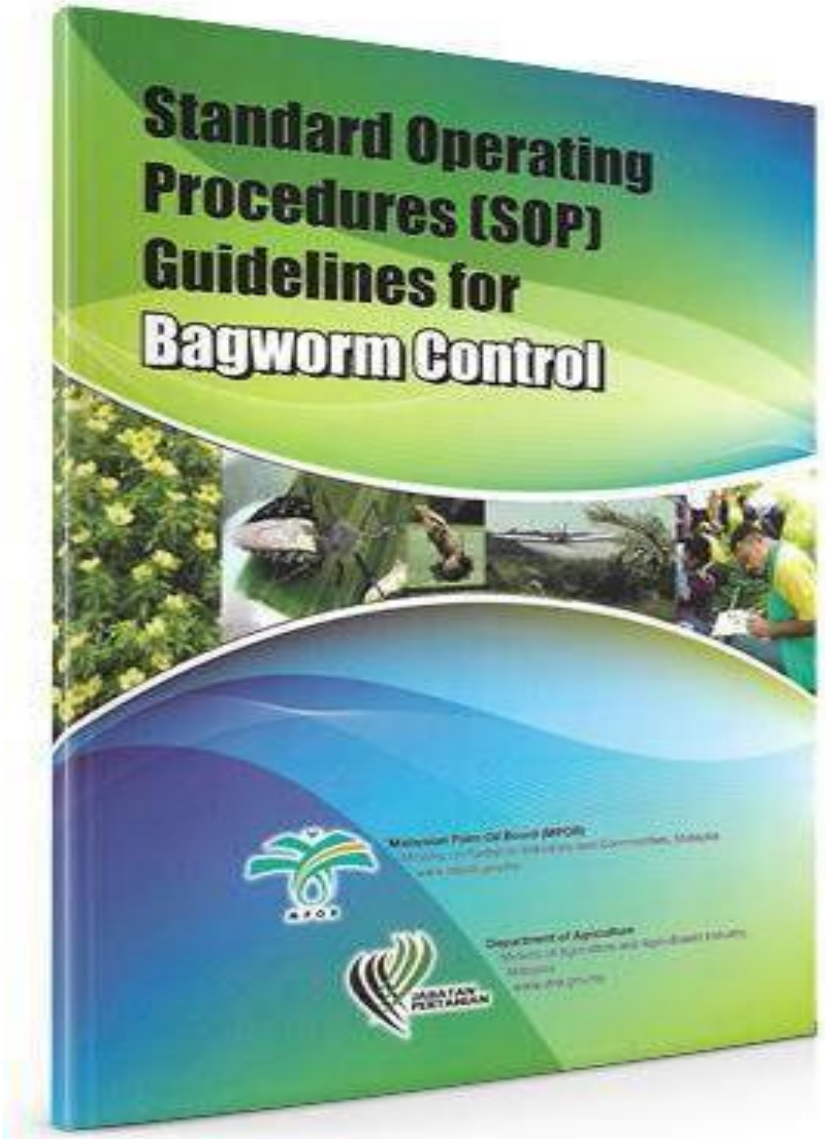
4 Core Components in IPM of bagworm

Bacillus thuringiensis (Bt)

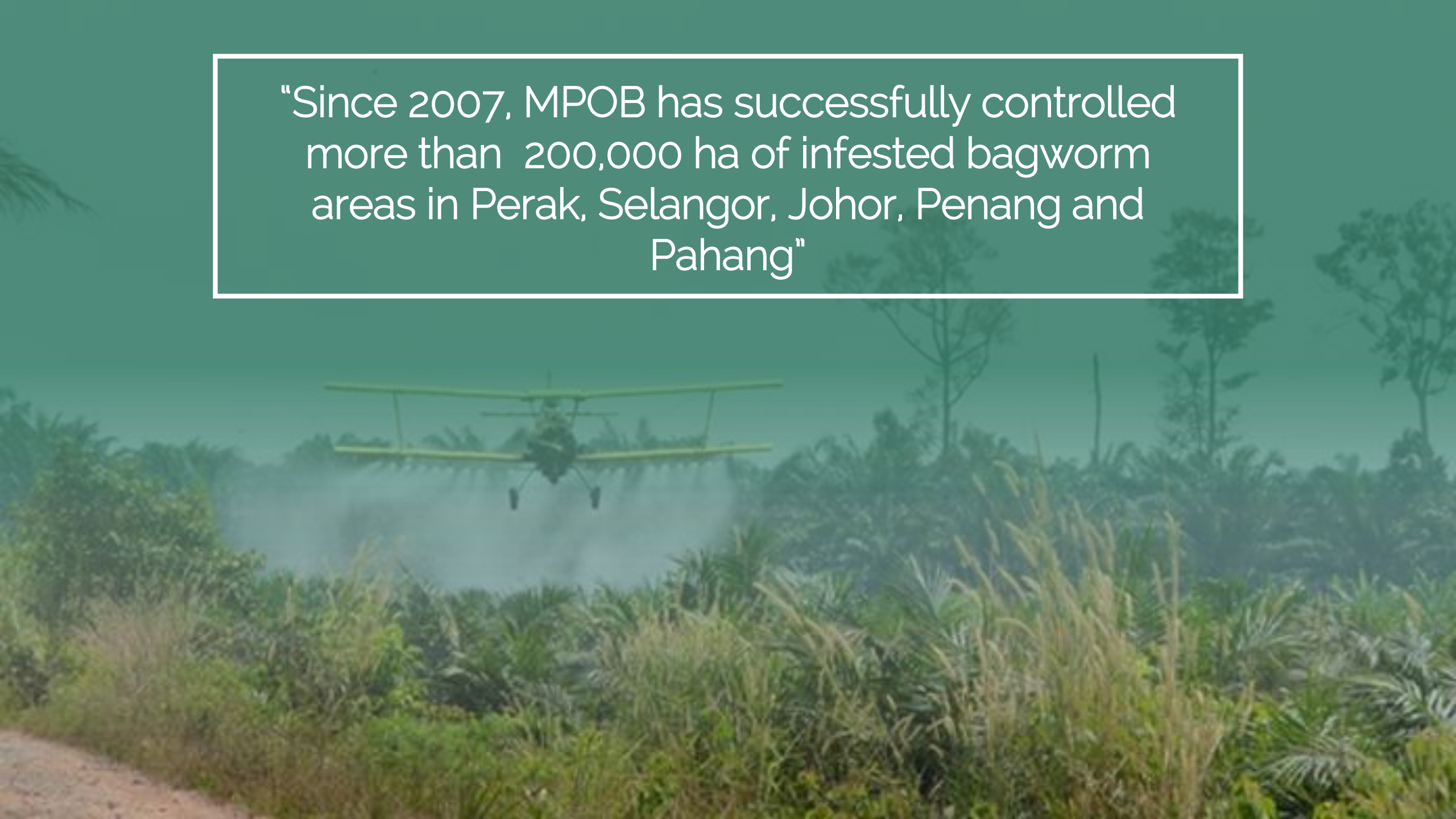
Beneficial plants

Beneficial insects (parasitoids & predators)

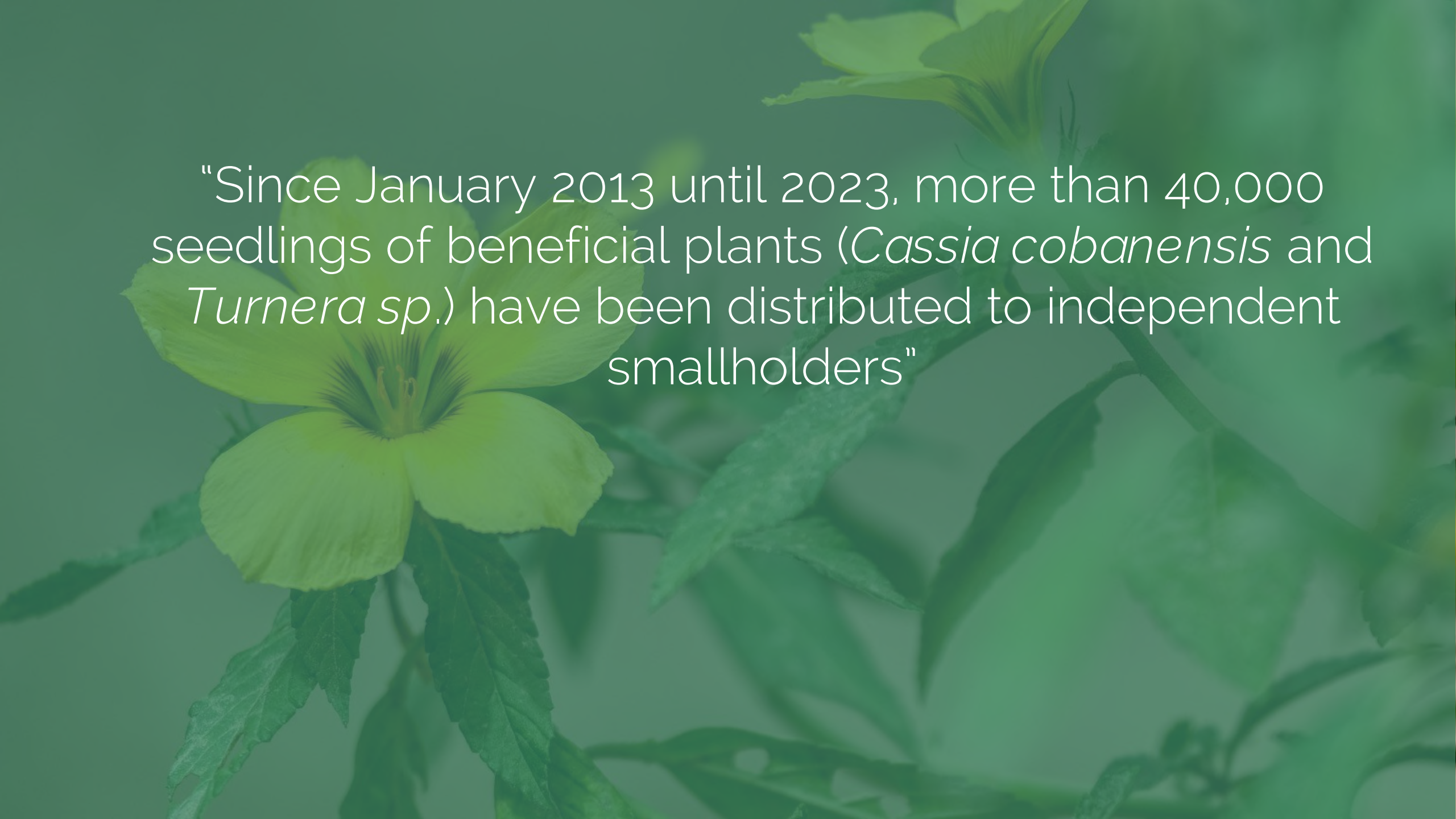
Natural pheromone trap



Details on the methodology of bagworm control through IPM in oil palm can be found in the SOP Guidelines for Bagworm Control.



"Since 2007, MPOB has successfully controlled more than 200,000 ha of infested bagworm areas in Perak, Selangor, Johor, Penang and Pahang"

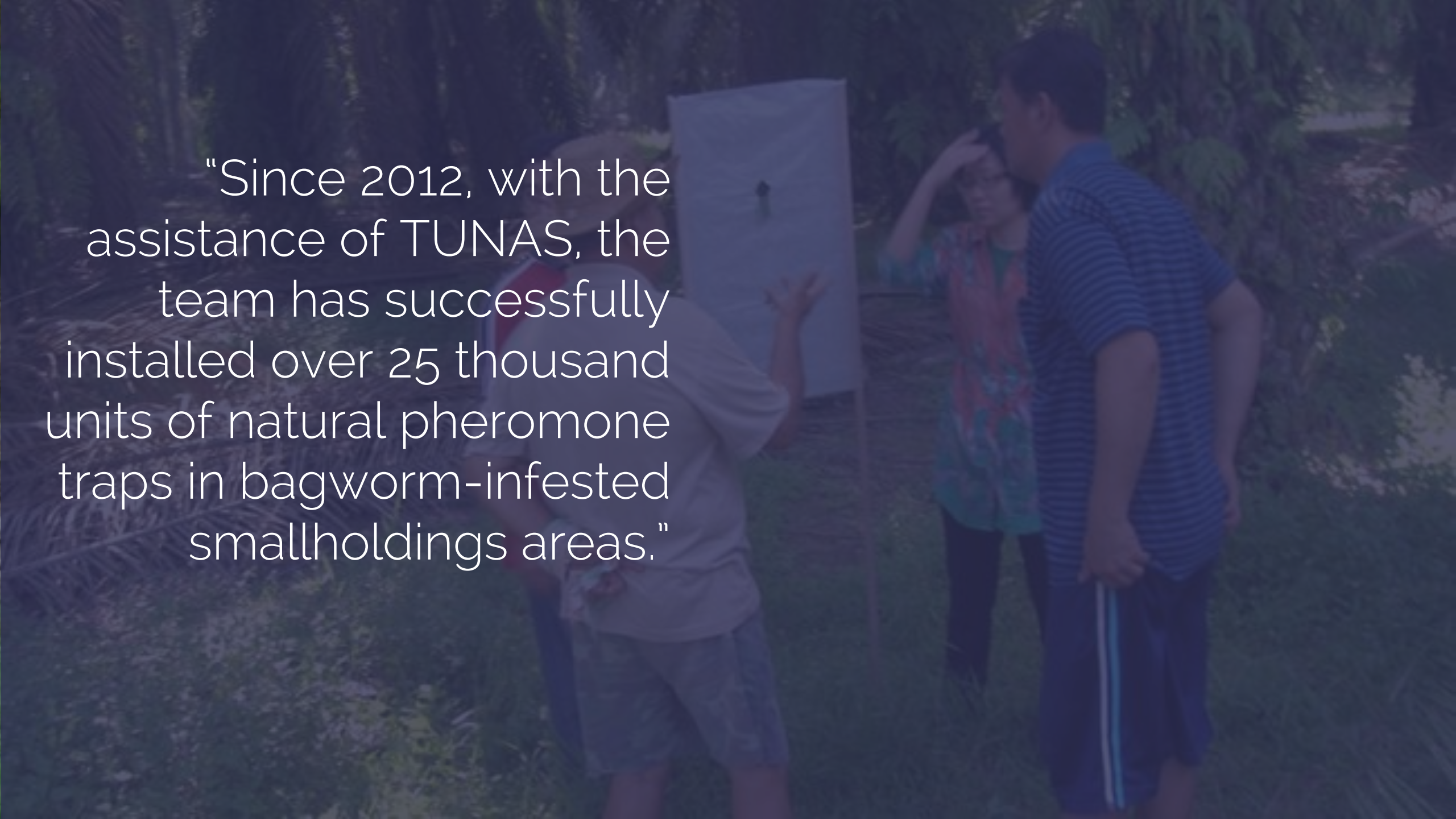


"Since January 2013 until 2023, more than 40,000 seedlings of beneficial plants (*Cassia cobanensis* and *Turnera sp.*) have been distributed to independent smallholders"

Demonstration by MPOB on the planting of beneficial plants

Distribution of the beneficial plants to the smallholders

Examples of well-established beneficial plants



"Since 2012, with the assistance of TUNAS, the team has successfully installed over 25 thousand units of natural pheromone traps in bagworm-infested smallholdings areas."

Pheromone traps for trapping the adult male moth

Pesawat terhempas di Muadzam Shah

Noraniza Kamsani

Februari 25, 2018 22:16 MYT

sia

The Way Forward

Drone aerial spraying using *Bacillus thuringiensis* (Bt)

Journal of Oil Palm Research Vol. 34 (2) June 2022 p. 276-288
DOI: https://doi.org/10.21894/jopr.2021.0045

EFFECTIVENESS OF *Bacillus thuringiensis* AERIAL SPRAYING AGAINST THE BAGWORM, *Metisa plana* WALKER (Lepidoptera: Psychidae) OUTBREAK IN OIL PALM USING DRONE

MOHAMED MAZMIRA MOHD MASRI[1]*; NOORHAZWANI KAMARUDIN[1]; NUR ROBAATUL MOHD ALI NAPIAH[1] and MOHD FAHMI KENI[1]

ABSTRACT

Bagworms have been a severe threat to the oil palm industry and have endangered mostly smallholdings. Thus, aerial spraying of Bacillus thuringiensis *(Bt) based bioinsecticides using an agricultural drone was carried out to control the bagworm infestation at a severely infested oil palm smallholding located in Sepang, Selangor, Malaysia. The drone was equipped with VP110 nozzle at the pressure of 0.2 MPa with a permanent speed of 2.8 m s^{-1}. The flying height was set 2 m above the canopy. The first round of drone spraying conducted on 4 July 2017 has successfully reduced the larval population of the bagworm,* Metisa plana *from 304.5 larvae per frond (LPF) at 0 days after treatment (DAT) to 12.1 LPF at 28 DAT, resulting to 96% reduction in the larval numbers. However, some of the larvae survived to the pupal stage, with approximately 64.52 pupae per frond (PPF) recorded at 28 DAT. The second drone spraying conducted on 27 August 2017 has effectively decreased the larval number from 109.25 LPF at 0 DAT to 9.3 LPF at 28 DAT, resulting in 91.5% of larvae reduction with zero pupae recorded. The results showed a great potential of drone aerial spraying in controlling bagworms at oil palm planting areas.*

Keywords: bagworm infestation, biopesticides, drones, unmanned aerial vehicles.

The Way Forward

Helicopter aerial spraying using *Bacillus thuringiensis* (Bt)

Transfer of Technology : Walbac (MPOB-Fermetec)

WALBAC

RACUN SERANGGA	IRAC 11A	PEKATAN TEREMULSI (EC)

Ulat Bungkus *(Metisa plana)* | Ulat Bungkus *(Mahasena corbetti)* | Ulat Bungkus *(Petroma pendula)*

Perawis aktif : *Bacillus thuringiensis*.....25.0% w/w
(*Bacillus thuringiensis*.....1 x 10^{11} cfu/ml)

No. Pendaftaran : LRMP. R/XXXX

Kandungan Bersih : 10 liter

Tarikh Mengilang :

Tarikh Luput :

Didaftarkan oleh:
Fermetec Resources Sdn Bhd (761233-U)
No 3, Jalan Nirwana 35,
Taman Nirwana,
68000 Ampang, Selangor, Malaysia.
Tel : 03-92829527

Jika berlaku **KERACUNAN,** sila hubungi **TALIAN KECEMASAN :**

999
TALIAN KECEMASAN NEGARA

BACA LABEL SEBELUM GUNA

JAUHKAN DARIPADA MAKANAN DAN KANAK-KANAK

KELAS IV

KEEP AWAY FROM FOODSTUFF AND CHILDREN

WALBAC ialah sejenis racun serangga biologi yang mengandungi perawis aktif daripada kumpulan *bacillus thuringiensis* yang bertindak secara di mana toksin protein mengikat reseptor pada membran usus tengah dan mendorong pembentukan liang, mengakibatkan ketidakseimbangan ionik dan septikemia.

ATURAN PENGGUNAAN : Penggunaan tidak mengikut label adalah satu kesalahan di bawah Akta Racun Makhluk Perosak 1974

TANAMAN	SERANGGA PEROSAK	KADAR RACUN		ISIPADU SEMBURAN SEHEKTAR	BILANGAN SEMBURAN MAKSIMUM SEMUSIM
		10 LITER AIR	SEHEKTAR		
Sawit	Ulat Bungkus (*Pteroma pendula*, *Metisaplana* dan *Mahasena corbetti*)	0.33 liter	1 liter	31 liter	2 kali

Panduan Membancuh: Disyor menggunakan alat penyembur galas, pam berenjin. Isikan tangki setengah penuh dengan air bersih. Campurkan **WALBAC** secukupnya mengikut syor yang ditetapkan dalam jadual sukatan dan bancuh. Seterusnya tambah baki air bersih yang diperlukan dan kacau. Jangan guna pada kadar lebih tinggi dari yang disyorkan. Jangan simpan baki bancuhan **WALBAC** di dalam tangki alat penyembur.

Panduan Menyembur: Lakukan semburan apabila tanda-tanda serangan mencapai tahap ambang tindakan (ATL). Untuk kawalan yang baik, sembur secara menyeluruh ke permukaan atas dan bawah daun. Ulangi semburan selang **7 hari** sekali apabila perlu sahaja. Semburan ulangan dijalankan apabila paras ambang ekonomi melebihi 10 ulat per pelepah bagi *Metisa plana* dan *Pteroma pendula* dan 5 ulat per pelepah bagi *Mahasena corbetti* pada hari ke-7 selepas semburan pertama. Jika rawatan perlu diulangi, gunakan **WALBAC** berselang-seli dengan racun serangga daripada kumpulan berlainan yang mempunyai cara tindakan berbeza. Jangan sembur pada waktu panas terik kerana ia boleh mengurangkan keberkesanan perawis aktif produk ini.

Tempoh Dilarang Masuk Semula Kawasan Rawatan (REI): 4 jam.

TANDA KERACUNAN:
Tanda Awal: Mual, muntah, cirit-birit, sakit perut, demam, kerengsaan (kemerahan, gatal).
Tanda Tertangguh: Tiada tanda keracunan spesifik. Segera dapatkan rawatan sekiranya mengalami sebarang tanda umum keracunan seperti mual, muntah, sakit perut, air liur berlebihan, sakit tekak, sesak nafas, ketat dada, nafas laju, berdebar-debar, gangguan deria rasa, kemerahan pada bahagian terdedah, sawan, koma atau sebarang masalah kesihatan.

AWAS:
a) Bahaya Kepada Manusia: Berbahaya jika tertelan. Elakkan daripada terhidu wasap atau kebus semburan. Elakkan daripada terkena kulit atau mata. Ketika mengendalikan produk ini, **JANGAN** makan, minum atau merokok. Selepas mengendalikan produk ini, pastikan tutup bekas racun dengan rapat dan simpan di tempat berkunci yang mempunyai peredaran udara yang baik, kering dan dingin. Cuci alat penyembur sebersih-bersihnya selepas menggunakannya. Pastikan mandi sebersih-bersihnya menggunakan sabun dan air yang banyak.
Pakaian dan Alat Perlindungan: Ketika mengendalikan produk ini, pastikan pakai pakaian pelindung diri (PPE) berpiawaian termasuk sarung tangan, gogal, kasut getah, penutup muka dan alat pernafasan mengikut kesesuaian (Rujuk Risalah Data Keselamatan).
b) Bahaya Pada Alam Sekitar: Produk ini adalah berbahaya pada organisma akuatik dan ikan. **JANGAN** cemarkan kolam, sungai atau saliran air. **JANGAN** sembur semasa lebah aktif mencari makanan.
RAWATAN KECEMASAN: Jika terkena pakaian, tanggalkan kesemuapakaian, mandi dengan segera dan ganti pakaian yang bersih. Jika terkena pada kulit, bersihkan dengan sabun dan air yang banyak. Jika terkena pada mata, tanggalkan kanta lekap (jika ada) alirkan air yang banyak pada bahagian mata sekurang-kurangnya 15 minit. Jika tertelan, **JANGAN** ikhtiarkan untuk muntah dan **JANGAN** beri apa-apa melalui mulut. Jika terhidu, pindahkan mangsa ke kawasan pengudaraan yang bersih. Bawa mangsa ke Pusat Perubatan/Klinik/Hospital yang terdekat dengan segera. Dinasihatkan bawa bersama label atau bekas racun perosak.
BILAS BEKAS KOSONG TIGA (3) KALI SEBELUM MELUPUSKANNYA. JANGAN GUNAKAN BEKAS RACUN UNTUK MENYIMPAN MAKANAN

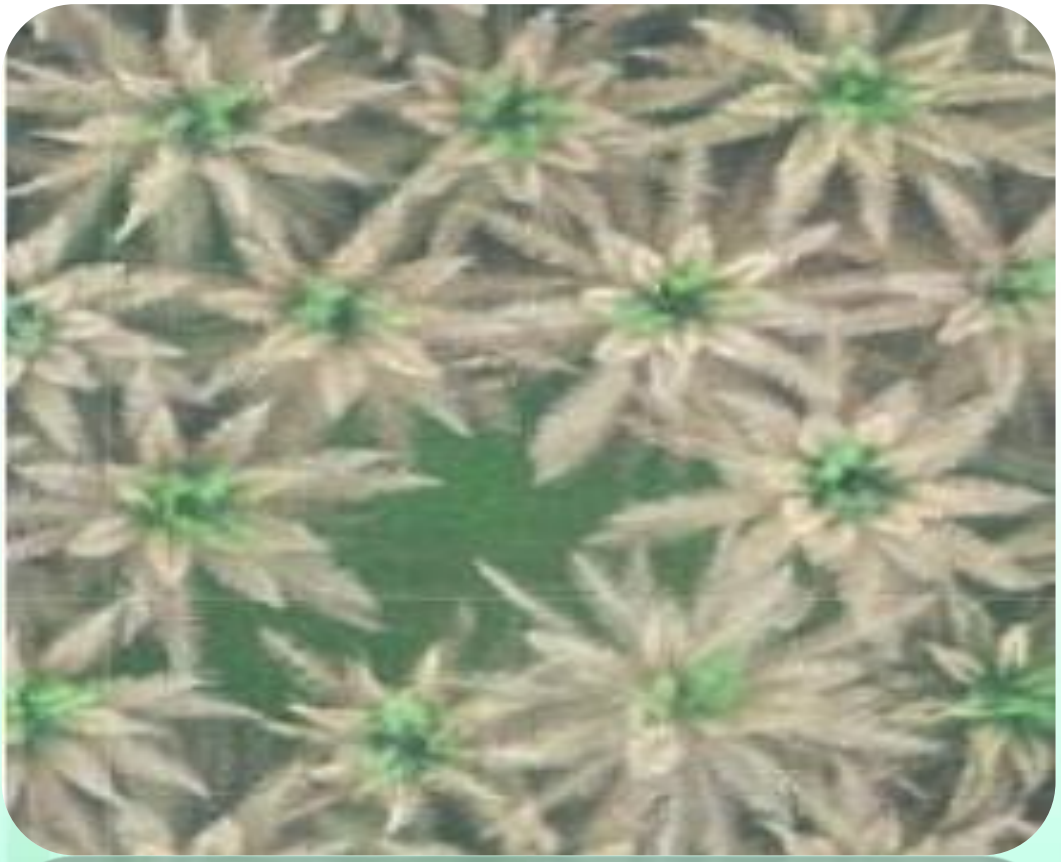
WALBAC RACUN SERANGGA IRAC 11A PEKATAN TEREMULSI (EC)
Perawis Aktif : *Bacillus Thuringiensis*.....25% w/w No Pendaftaran: LRMP.R/XXXX
Didaftar oleh: Fermetec Resources Sdn Bhd (761233-U) Tel : +603-92829527

勿貯藏在靠近食品
或兒童所接觸的地

KELAS IV

உணவுகள் மற்றும்
குழந்தைகளுக்கு
அருகில் வைக்காதீர்

The Impact of Walbac Aerial spraying at Oil Palm Smallholding



Before

After

THE POTENTIAL USE OF SELECTIVE INSECT GROWTH REGULATORS (IGRs) FOR GROWTH DISRUPTION OF OIL PALM PESTS (BD454-2019)

OBJECTIVES

- To evaluate selected insect growth regulators (IGR) compounds and suitable ratios for their effects on bagworm growth and survival.
- To determine effective concentrations for the activity of IGRs against bagworms.
- To determine the effect of selected IGRs on non-target organisms.

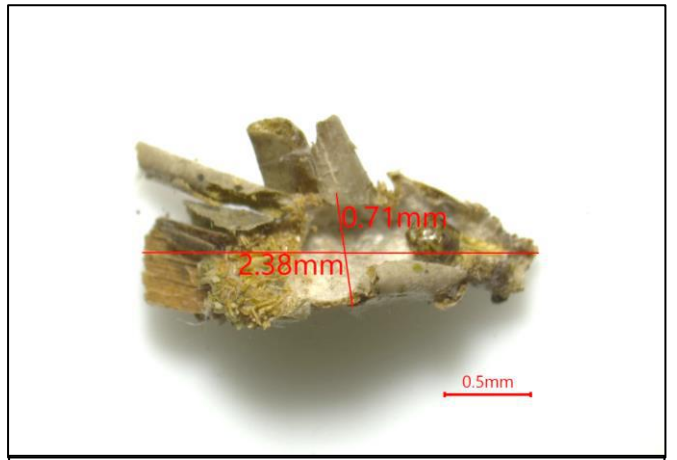
SIGNIFICANT ACHIEVEMENTS

- Laboratory trials for all IGR compounds are almost completed for middle and late larval stages of bagworm, *Metisa plana* from several locations in Peninsular Malaysia.
- Morphological changes, disruption of growth and feeding index were observed.

TIMELINE

Year/Quarter	2019				2020				2021				2022				2023			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Insect collection and rearing		→	→	→	→	→	→	→	→	→	→	→	→	→	→	→				
Preliminary data collection			→	→	→															
Data collection & analysis						→	→	→	→	→	→	→	→	→	→	→	→	→		
Preparation of report & findings																	→	→	→	

The IGR-treated larvae (top) in comparison with control larvae (bottom)



Post-mortem and morphological inspection of the IGR-treated larvae

PROGRESS BD436-2015

Toxicity And Resistance In Bagworms Towards Chemical Insecticides

OBJECTIVE:

i) To identify plantations with bagworm populations that have been continuously exposed to chemicals for 20 years.

ii) To provide scientific data on bagworm resistance as a result of prolonged exposure to chemicals.

SIGNIFICANT ACHIEVEMENT

i) The assessment of bagworm populations in Perak and Johor yielded predominantly positive results, with no resistance observed in the field.

Ii) However, it is imperative to acknowledge an exception in the Besout area (ES2) of Perak, where bagworm populations displayed a degree of tolerance to specific insecticides, namely trichlorfon and lambda-cyhalothrin.

-This project were closed (VIVA) on 23 August 2023.

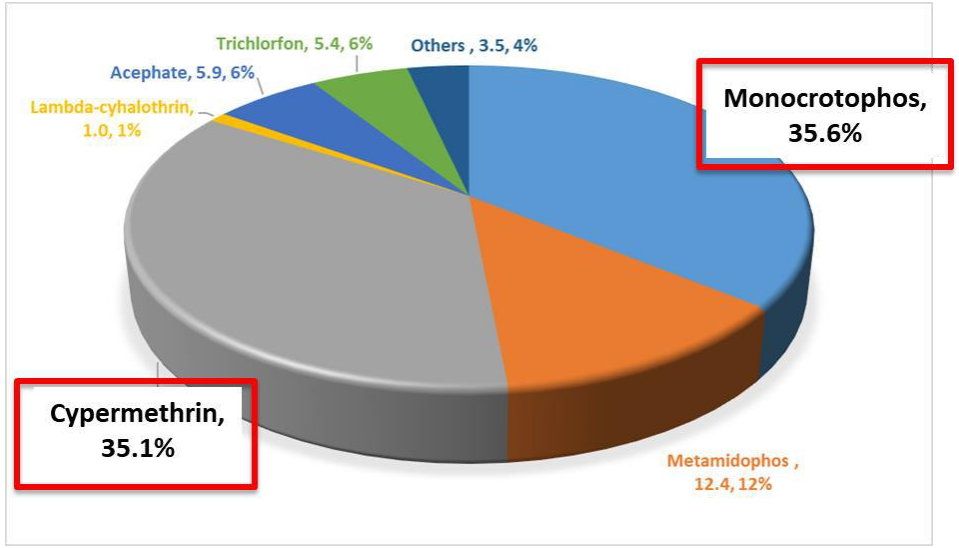


Figure 1. Pesticide usage in oil palm plantations in Perak and Johor

TIMELINE

	2015		2018				2019				2020				2021				2022			
Year/Quarter	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2						
Survey and Sampling	→	→	→	→	→	→	→	→	→	→												
Sampling and screening toxicity level							→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Data Analysis			→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Report Writing															→	→	→	→	→	→	→	→

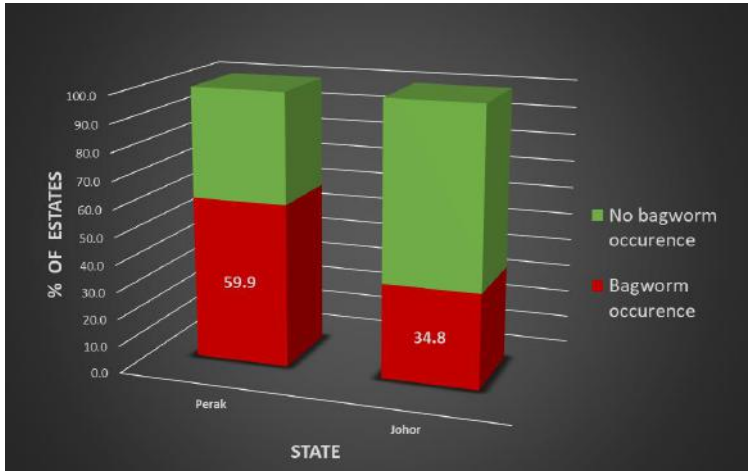


Figure 2 Bagworm occurrences in oil palm plantations in Perak and Johor

PROGRESS BD450-2018

The Effect Of Environmental Factors Towards Life Cycle Of Bagworm, *Metisa plana* Walker (Lepidoptera : Psychidae) In Peninsular Malaysia

OBJECTIVE:

- To determine the life cycles of bagworm that may be affected by the environmental factors
- To identify the effect of environmental factors on the population dynamics in particular outbreak of the bagworm

Temperature and humidity were collected using an anemometer

SIGNIFICANT ACHIEVEMENT

- Temperature promote a positive correlation with *M.plana* population however relative humidity shows negative correlation with the pest population .

- One indexed journal in title "Impact of environmental factors on the larval population of bagworm, *Metisa plana* Walker (Lepidoptera: Psychidae in oil palm smallholdings were published in Serangga, 28(2): 149-161.

- This project were closed (VIVA) on 24th October 2023

The mated pupae are cover by nylon organza

TIMELINE:

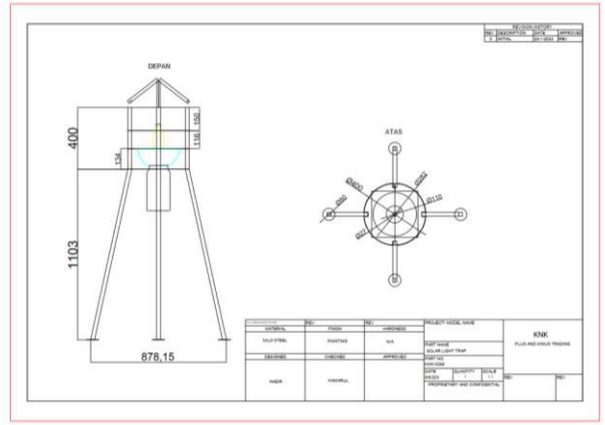
Year	2018				2019				2020				2021				2022				2023			
Activities/ Month	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Collecting the data of environmental factors	→																							
Data analyses									→															
Report writing and VIVA																				→				

PROGRESS YP3/18-2022

Efficiency of Different Source of Light Trapping Against Male Moth of Bagworm, Metisa Plana Walker (Lepidoptera: Psychidae) In Oil Palm Plantation

OBJECTIVES

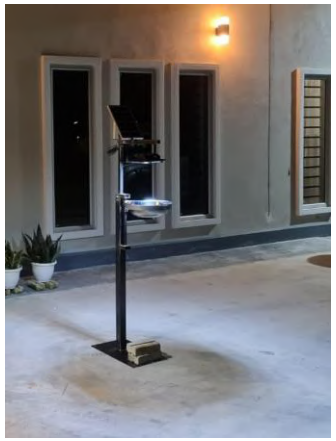
- To study the efficacy of different types of light source for capturing adult male moths M.plana
- To identify the abiotic factors for better understanding of the behavioral pattern prediction and pest population monitoring in oil palm plantations



The sketch of solar light trap

SIGNIFICANT ACHIEVEMENTS

- The site for this project will be located in MPOB Bagan Datuk, Air Kuning C in Perak and MPOB Keratong, Pahang.
- The purchasing of 8 units of solar light trap is under process and will going field trial on December 2023.



The protype of solar light trap

TIMELINE

	2022				2023				2024				2025			
Year/Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Selection of sampling site, sampling and collection data			→		→	→	→	→	→	→						
Data analysis and report writing			→		→	→	→	→	→	→	→	→	→	→		

PROGRESS BD456-2019

Development Of Biopesticide Using Integrated Omic Approaches For Effective Strategy To Control Bagworm Infestation In Oil Palm Plantation

OBJECTIVES:

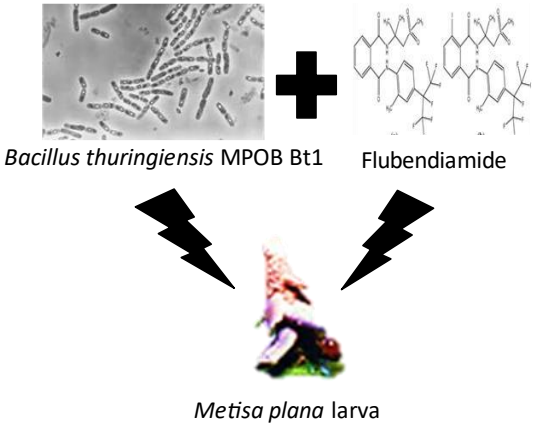
i. To conduct genome sequence analysis of *Bacillus thuringiensis* MPOB Bt1 and assess its synergy with flubendiamide for controlling oil palm bagworm (*Metisa plana*, Walker) larvae.
ii. To investigate the community succession of the microbiome of *M. plana* larvae following pesticide treatments.
iii. To characterize the functional aspects of the metagenome-assembled genome community in relation to the response to pesticide treatments.

RESEARCH PROGRESS:

i. Individual MPOB Bt1, flubendiamide, and their combination show toxicity to *M. plana*, with synergistic effect observed for combined Bt-F treatment.
ii. The microbiome analysis recorded that *Enterobacter* and *Pseudomonas* showed positive correlations with *Bacillus* in the combined Bt-F treatment.

TIMELINE:

Year Quarter	2019				2010				2021				2022				2023			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
MPOB Bt1 Whole Genome Sequencing			→						→											
Bioassay Synergism Optimization					→								→							
Shotgun Metagenomic Sequencing & Analysis								→									→			



PROGRESS YP3-3/2021

Comparative Transcriptome Analysis of *Metisa plana* Walker (Lepidoptera: Psychidae) Infestation in Oil Palm Plantation Exposed to Different Chemical Insecticides and Biopesticide

OBJECTIVES:

i. Generate transcriptome data from *M. plana* 4th instar larvae collected from selected oil palm plantations that have been exposed to different insecticides
ii. Identify *M. plana* genes that are involved in insecticide resistance
iii. Identify differentially expressed genes between bagworms exposed to different insecticides
iv. Validate genes involved in insecticide resistance using qRT-PCR.

RESEARCH PROGRESS:

1. 261,955 transcripts of bagworms collected from 4 different locations in Perak have been generated and gene functional annotation has been conducted.
2. Among them, 2 cadherin genes and 14 ABC transporter genes which are known as Bt receptor, were reported to be down-regulated. One of the cadherin gene has been confirmed the down-regulation by using qPCR analysis.

TIMELINE

	2021		2022				2023				2024				2025	
Year/Quarter	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Sampling and RNA isolation			→													
Sequence Assembly and Annotation						→										
Gene Expression Analysis							→									
Data Analysis												→				

Table 1. Genes potentially involved in biopesticide resistance in M. plana *identified through annotation*

Genes	Number of genes
Detoxification genes	
Cytochrome P450	25
Glutathione S-transferase	8
Carboxylesterase	6
***Bt* toxin receptor**	
Acetylcholinesterase	2
Cadherin	13
Aminopeptidase N	5
ABC transporter	6
ATP-binding protein	33

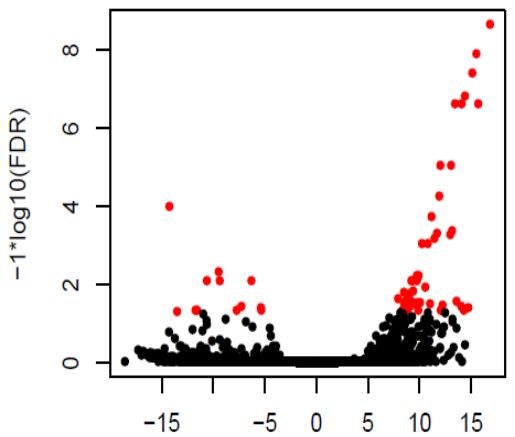
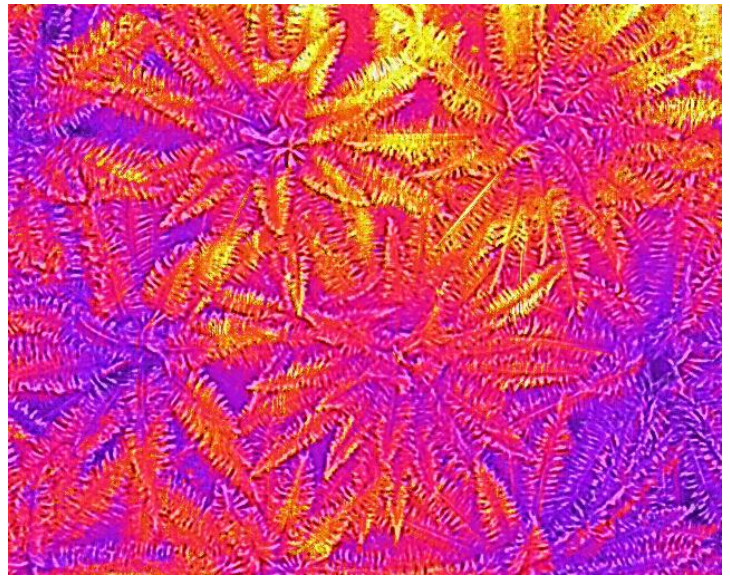


Figure 1. Volcano plot of DEG for Bt-R-Mp vs Bt-S-Mp

PROGRESS YP3-2/2021

TITLE: Development Of Integrated Drone With Hyperspectral And Thermal Camera For Detection And Infestation Severity Of Bagworm Attack In Oil Palm.



OBJECTIVE:

- To identify significant bands for bagworm detection at plantation environment extracted from hyperspectral and thermal camera.
- To identify suitable indices for bagworm detection.
- To develop suitable models for bagworm detection at four severity levels of infestation for plantation environment.

SIGNIFICANT ACHIEVEMENT

- Trial for thermal camera with drone has been done at Independent Smallholder oil palm area in Air Kuning, Perak and Penang for test on severity of bagworm infestation.

TIMELINE

Year	2021		2022				2023		
Activities	3	4	1	2	3	4	1	2	3
literature review	→	→							
Equipment preparation		→	→	→					
Data collection				→	→	→	→	→	→

CONCLUSIONS

- The IPM program has successfully reduced the bagworm population in severely infested areas. The effect can be seen clearly after two years of IPM application in the infested areas.

- With implementation of IPM, the bagworm problem can be managed proficiently using high tech tools such as drones and effective for long-term control.

- MPOB's unwavering dedication to the Integrated Pest Management (IPM) strategy is crucial in controlling the bagworm outbreak in oil palm.

- Through ongoing research, MPOB not only refines the current strategy but also lays the groundwork for an evolved approach, ready to tackle future challenges. This commitment to excellence ensures the resilience of the oil palm industry against persistent bagworm infestations