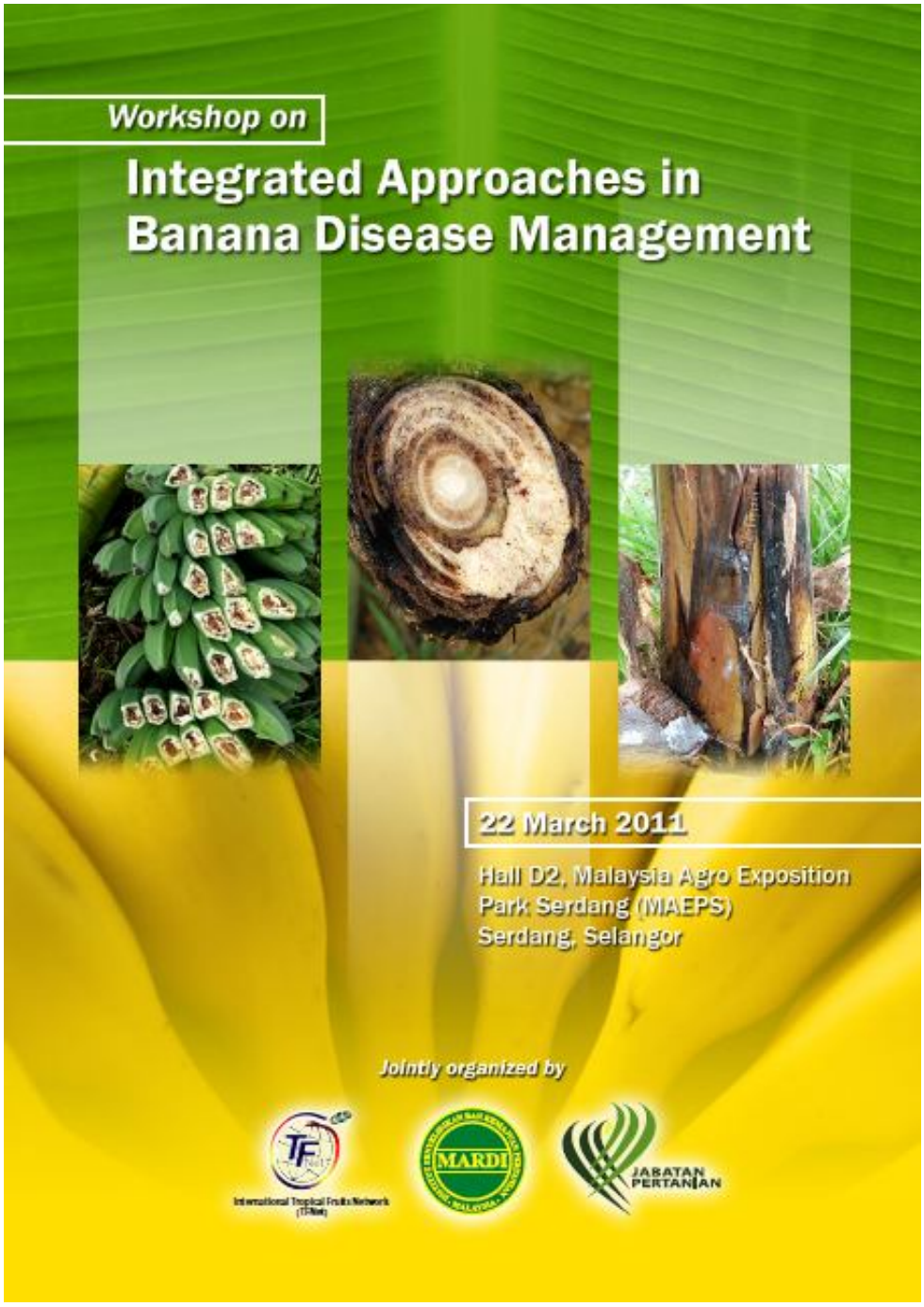
PROCEEDINGS ON

WORKSHOP ON 'INTEGRATED APPROACHES IN BANANA DISEASE MANAGEMENT'

MAEPS, SERDANG, MALAYSIA

22 MARCH 2011



CONTENT

ACKNOWLEDGEMENTS

Organizers of the workshop, International Tropical Fruit Network (TFNet), Malaysian Agricultural Research and Development Institute, Malaysia (MARDI) and Department of Agriculture, Malaysia (DOA) would like to extend their gratitude to the following for their support and cooperation:

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Dr. Li ChunYu, Fruit Tree Research Institute, GDAAS, Guangzhou, China

Dr. Agustin Mollina, INIBAP, Los Banos, Philippiness

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Focus Horticulture Sdn. Bhd, Tanjung Malim, Perak, Malaysia

World Agri Trade, Petaling Jaya, Selangor, Malaysia

All members of the organising committee from MARDI, DOA and TFNet

All workshop participants

SUMMARY

Workshop participants were given a scenario of the status of Panama (Fusarium) Wilt Disease and MOKO disease caused by *Pseudomonas* spp on bananas in China, Indonesia, Malaysia and the Philippines. The various containment measures such as biological control using Chinese leek, induced resistance against Fusarium Wilt and cultural methods practiced in the countries around the region were also discussed.

Concerned with the increasing incidences of these diseases, participants concurred that national initiatives as that practiced in Indonesia and China must be implemented to contain these diseases, especially Panama Wilt Disease.

The initiatives should include implementation of good cultural practices, eradication of diseased trees and burning and isolation of infected areas, use of disease free planting materials, encourage use of tissue cultured materials, disinfection of tools and equipment, planting of tolerant varieties, crop rotation and more research and development to reduce disease incidences.

The participants of the workshop felt that it was imperative to set up a National Banana Disease Task Force to monitor and coordinate operations and activities required for early detection that will mitigate incidences and spread of both these devastating banana diseases. The Task Force would also advise the agencies on methods and cultural practices to minimize crop damage.

1. INTRODUCTION

Over the decades, Malaysia had increased focus in the production of commercial varieties of banana such as the Berangan and Cavendish varieties. Many commercial growers ventured into large scale planting either as a monocrop or inter-cropped during the juvenile period with plantation crops such as oil palm, coconut and rubber. The demand for selected banana planting materials also encouraged the micro propagation industry through tissue culture laboratories in Malaysia. Currently, there are more than 7 laboratories producing about 1.5 million banana plantlets of all cultivars per year.

The area planted with banana increased 24 percent to 27,453 hectares in 2009, as compared to 2008. With the increase in planted area, there was also a noticeable increase in disease incidences. One serious disease which impacted the industry is Panama wilt, which is caused by *Fusarium oxysporium*. sp *cubense* (Foc)., specifically the tropical race 4. The dramatic escalation of the disease throughout the country has resulted in decreased production, especially the Cavendish variety of bananas.

In 2007, the MOKO disease, caused by a bacteria *Pseudomonas* spp, was identified to infect local cooking banana varieties such as the nipah variety. The detection of this disease has further dampened the growth and expansion of the banana and plantain industry in Malaysia.

Better understanding of disease epidemiology, effective management and control of these diseases are central to the successful production of banana and plantain.

Cognizant of the impact of these diseases on the Malaysian banana Industry, International Tropical Fruits Network (TFNet), MARDI and Department of Agriculture jointly organized a one day workshop - 'Integrated Management of Banana Diseases' at the Malaysia Agro Exposition Park (MAEPS), Serdang, Selangor, Malaysia on 22 March 2011. The objectives of the workshop were to enhance the knowledge of the participants on the overall management of the banana diseases. The specific objectives of the workshop were to:

- impart basic information on distribution, causal agent, mode of spread and control of the diseases to partcipants
- share and exchange views with experts from China, Philippines, Indonesia and Malaysia on the management of the diseases.
- provide guidelines on the effective management these diseases in Malaysia.

More than 180 participants from the research, production, marketing and advisory services of the banana industry in Malaysia attended the workshop.

The resource persons for the workshop were leading experts in banana cultivation and disease management from China, Indonesia, Philippines and Malaysia.

2. PRESENTATIONS AND DISCUSSIONS

2.1. 'The status banana industry and the disease incidences in Malaysia', by Mr . Mokhtarud-din Husain, Deputy Director, Crop Protection and Plant Quarantine Division, Department of Agriculture, Malaysia

Mr. Mokhtarud-din informed that banana is mainly grown in Malaysia as a smallholder crop in a total land area of about 27,500 hectares, with Johore, Pahang, and Sarawak as the largest banana producing states. He also stated that large companies are starting to venture into banana cultivation with more organised management. He also informed that Malaysia exports bananas to Singapore, Indonesia, Brunei, Saudi Arabia, and Hong Kong and imports banana chiefly from Philippines and Thailand.

The cultivars grown in Malaysia are both the dessert and cooking types. The dessert cultivars include Mas, Berangan, Cavendish, and Rastali, while the common cooking banana cultivars are Nangka, Raja Lang, Relong, Tanduk, Nipah and Pisang Awak. The Berangan and Cavendish banana account for about 50% of the total cultivars grown.

He also pointed out that the wide spread of *Fusarium* wilt disease and the recently discovered MOKO disease, have affected the production of banana for both dessert and cooking varieties. Several measures have been taken to reduce these menaces, however, with limited success.

Outlining the strategies for effective control, Mr. Mokhtaruddin informed that both *Fusarium* wilt and MOKO disease will continue to be the major constraint to banana sector growth in the foreseeable future. To prevent the spread, all stakeholders need to increase their vigilance and take pre-emptive action to destroy infected plants as soon as they appear. Capacities to recognize the diseases and to deploy rapid eradication responses are vital to the containment of these two diseases.

Comments to the discussion

For effective control of MOKO disease, Mr. Mokhtarud-din pointed out that it is important to know the alternate hosts present within the borders of banana plantations. One of the alternate host that has been identified is *Helicornia spp,* (family: *Heliconiaceae* and order: *Zingiberales*). He believes that early detection, especially at the nursery stage, is vital because the disease can be easily identified and plants can be culled to prevent the further spread of the disease.

Dr. Gurmit Singh raised concern on the rapid spread of MOKO disease in Malaysia and urged everyone to be more vigilant and take the necessary control and eradication actions to prevent further spread. He further ascertained that bacteria-caused MOKO disease is more devastating as compared to fungal diseases. With regards to Foc, he said that there are some tolerant varieties available but field upkeep, balanced fertilisation, and better sanitation are necessary to prevent further spread.

There were differences in opinion about the susceptibility of tissue culture materials to Foc. Some experts opined that tissue culture materials are more susceptible to Foc while others are not. It was generally agreed that the susceptibility to Foc varied with different cultivars. However, most participants were convinced that tissue cultured materials are free of Foc at the nursery stage but get infected in the field.

2.2. '**Status of Banana Diseases Research in Malaysia' by Y.M. Tengku Ab. Malik Tengku Maamum, Director of Horticultural Research, MARDI, Malaysia**

Referring to the dynamic nature of disease spread and the impact on the industry, Tengku Malik emphasized that the need for research and identifying solutions were tasks of research organisations such as MARDI, Universities and private agencies in the coming years. He concurs that the Foc pandemic can be due to mono-cultivar cultivation, and poor field and crop management.

Research studies on the use of chemical basamid fumigation, formalin, and magnesium limestone were not effective to control Foc. However, other management practices such as organic cultivation and crop rotation could offer some solution to minimize Foc.

Screening for resistance against Foc on 23 banana hybrids and somaclonal materials, MARDI discovered that Cv Rose, P. Jari Buaya, and Calcutta 4 were resistant but had no economic value. Nonetheless, they are viable sources of genetic materials for future breeding. Hybrid FHIA-18, FHIA-21, and FHIA-25 were found to be tolerant against Foc but are not well accepted by consumers. However, research work indicates that commercial bananas like Gros Michel, Cavendish (cv William), P. Berangan Intan, and P. Mas were found to be susceptible to Foc.

Tengku Malik also highlighted that MARDI has developed a microsatellite marker for Foc TR4 resistance with the ability for fast and early screening compared to conventional techniques. Future research focus will be based on these findings for commercial utilization.

Comments to the discussion

In response to the question on the radiation-induced mutation research with the Malaysian Institute for Nuclear Technology Research (MINT), Tengku Malek mentioned that there are currently no resistant mutagenesis against Foc and the only way to differentiate between resistant and tolerant varieties is by carrying out DNA analysis. He agreed that the variety 'Pisang Kapok' is resistant to Foc but is not well accepted by the consumers, which were also agreed by Dr. Mollina of INIBAP.

2.3. 'Integrative Approaches for Managing Banana Fusarium Wilt in China' by Dr. Li Chun Yu, Senior Research Officer, Fruit Tree Research Institute, GDAAS, Guangzhou, China

Dr. Li Chun Yu informed that Foc was first discovered in Panyu District, Guangzhou City in 1996 and later spread to many other banana growing areas of Guangdong, Hainan, Fujian, Guangxi, and Yunnan provinces by the way of plantlets, suckers, water, among others. The farmer's preference of planting by using suckers had caused the spread of FocTR4 throughout China, leading to farmers suffering from heavy losses.

He informed that scientists and farmers adopted several mitigation measures, including chemical control, crop rotation, rice and other aquatic crops intercrops, resistant varieties, biological, control and other cultural practices to manage this disease. He further elaborated that chemical control method is most widely practiced in China and the use of fungicides capsules by way of injecting into root, pseudo stem, sucker, and sheath are being studied for

efficacy evaluation. Other biological control approaches such as the use of *trichoderma* and bacterial strains are being evaluated against Foc. He also highlighted that the trials on intercropping banana with Chinese leaks (*Allium* sp) has shown to reduce the spread of Foc.

He also mentioned that the researchers have identified that Foc Race 1 and 4 secrete two types of toxins, ie., Beauvericin and Fusaric acid, that can cause banana plant to wilt.

Dr. Chun Yu suggested that when the Foc disease incidence exceeds 20% of the total crops, the banana orchard should be replanted with other crops. The diseased plants must also be burned and buried underground, and the planting hole must be treated with fungicides or lime. Balanced fertilization among nitrogen, phosphorus and potassium, and additional application of calcium and magnesium are required to improve the plant's disease-resistant properties

Comments to the discussion

In response to the question on the susceptibility of Cavendish banana to Foc, Dr. Mollina confirmed that tissue culture materials are generally free from both *Fusarium* and moko diseases. However, they are susceptible once planted in the field due to presence of inoculums and other cultural activities that may trigger the multiplication and further spread of microbes. The absence of other antagonistic microbes within the field may also accelerate the spread of the pathogen.

2.4. 'Managing Banana Diseases - The Indonesian Experience' by Dr. Siti Subandiyah, University of Gadja Mada, Jogjakarta, Indonesia

Dr. Siti Subandiyah highlighted that the decline of Indonesia's banana export was mainly due to the spread of diseases, especially blood disease caused by Blood Disease Bacterium (BDB) and Fusarium wilt caused by *Fusarium oxysporium* fsp. Cubense (Foc). Foc is common, however, BDB is the major concern at the moment. In addition to this, Banana bunchy Top Virus (BBTV) is also becoming a serious threat.

She highlighted the various research works being carried out on BDB and Foc. The BDB is a soil-borne pathogen and laboratory results showed that it is a slow growing organism on agar medium. BDB is mainly transmitted by insects and by other mechanical means. Cooking bananas such as kepok, saba, and pisang awak were found with high incidence of BDB as compared to dessert banana. She confirmed that BDB survives on *Heliconia* spp. *and Canna* spp but found not to be infectious to solanaceaous plants.

With regard to Fusarium wilt, field trials indicated that that Barangan was highly susceptible towards Foc TR4 infection, dying in the first year after field planting, whereas cultivar Kepok Kuning, Puju, and Panjang were more resistant and survive until the fifth year. Her studies also showed that the resistance mechanism of banana cultivar was correlated with peroxidase activity in the plant roots. The higher peroxidase activity, the more resistant the banana cultivar towards TR4 of Foc infection.

For better understanding on the differences between BDB and Foc, she highlighted their disease epidemiology and characteristics of symptoms.

Comments to the Discussion

In response to the question on the spread pattern of Foc, especially on the tissue cultured material, Dr. Siti emphasized that the proper selection of mother plant is very important. It should be free from Foc infected areas. However, they are susceptible once planted in the field due to presence of the pathogen and other cultural activities that may cause the spread. She also confirmed that Pisang Ambon (Gross Mitchel) is more susceptible to Foc as compared to kepok. However, kepok is more susceptible to MOKO disease compared to Gross Mitchel.

Dr. Gurmit Singh mentioned that based on his experiences, planting of tissue cultured berangan banana in between palm oil trees delayed the spread of Foc compared to plants grown from suckers. Moreover tissue cultured produced uniform growth and better yield.

The participants agreed that more work needs to be done in Malaysia, especially confirming the organism that causes MOKO disease. This disease has been interchangeably used as blood disease because of similar wilting symptoms though the causal pathogens are different. MOKO disease is caused by *Pseudomonas solanacearum* while blood disease is caused by *P. Pseudomonas celebensis.*

2.5. 'Induced Resistance Of Banana Against Fusarium Wilt' by Dr. Christanti Sumardiyono, University of Gadja Mada, Jogjakarta, Indonesia

The study on the use of Fluorescent pseudomonads (FP) for resistance evaluation was highlighted. Her evaluation has shown that the use of Fluorescent pseudomonads plus non-pathogenic *Fusarium* spp have induced resistance of banana plants against Foc. Other experiments on the use of compost enriched with Fluorescent pseudomonads also have shown to reduce the disease intensity of Foc compared to non-pathogenic *Fusarium* spp in compost.

She also highlighted that treated plantlets with fusaric acid reduced diseased intensity of *Fusarium* wilt in heavily infected fields, but affecting the plant growth.

In conclusion, she suggested that sufficient doses of compost and NPK fertilisers will help better plants growth and will further delay the infection of the Foc

2.6. 'Control of Fusarium wilt in banana with Chinese leek' By Dr. Yi Ganjun, Director, Fruit Tree Research Institute, GDAAS, Guangzhou, China.

Dr. Yi Ganjun highlighted the impact of *Fusarium* wilt and the damage to the banana industry in China. He pointed out that Foc has destroyed the banana plantations in the main banana producing areas such as Guangdong, Hainan, Guangxi, Fujian, and Yunnan. Currently, the disease incidence in the delta of the Pearl River (a major banana producing area in China), ranges between 10 to 40 percent, with individual plantations reaching to 90% and led farmers to abandoning their farms.

He further explained that in the researchers undertook missions to explore the ways and means to overcome this disease problem. One of the observations that was communicated by some growers is the planting of banana rotated with Chinese leek (*Allium tuberosum*) which showed lower incidences of Fusarium wilt. The observation prompted researchers to

carry out both qualitative and quantitative studies to evaluate further the interaction between Chinese leeks and reduced Fusarium wilt incidences.

Their three-year study indicated that the incidence of the disease is found to be nearly 30 times less in bananas trees planted with Chinese leeks on the first year, 13 times less on the second year, and 8.6 times less on the third year. Likewise, the disease is 30 times less severe in plants with the Chinese leeks on the first year, 17 times on the second year, and about 11 times on the third year. The yield produced was about twice more in the bananas planted with Chinese leeks on the first year, 36% more on the second year, and about 50% more on the third year.

Dr. Yi also explained that pot experiments with Chinese leek indicated a decrease of disease incidence and severity during the immature period of the plant. He also revealed that laboratory experiments showed that water extract of Chinese leek suppressed proliferation of the spores of *Fusarium oxysporum* f. sp. *Cubense.*

He concurred that while the rotation system with Chinese leek-banana is an alternative way to control banana *Fusarium* wilt showed promise, further studies need to be carried out.

Comments to the discussion

In response to a question on the amount of Chinese leeks used in potted trials, Dr Yi informed that 20g/pot is sufficient to lower the inoculum's potential to cause wilting. He also informed that there are many complex compounds extracted from *Allium* sp and more work need to be done to identify the single compound that is responsible for the reduction on the disease incidence. He also confirmed that *Allium* sp. leaves show better results as compared to roots in suppressing the pathogen. However, more work need to carried out to further ascertain the initial finding.
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2.7. and 2.8. 'Banana diseases: Continuing major production constraint' and 'Research and Development Challenges in Asia and Disease Management approaches in the Philippines' by Dr. Augustin Mollina, INIBAP, Los Banos, Philippines

In his presentation, Dr. Mollina covered a wide range of banana diseases and their impact to the banana industry and the Philippine economy. Diseases such as panama wilt, Sigatoka, MOKO, blood disease, and viral diseases are the main diseases of banana and affecting Philippine production like other countries.

He also touched on the discovery of these diseases in various countries and their chronology of spread and the gravity of their problems. Almost all major banana growing countries are affected by these diseases and it is estimated that more than 2 million hectares of banana plantation in worldwide are affected by one of these diseases.

He also mentioned that in the 1990's commercial Cavendish plantations were established in both Malaysia and Indonesia for the export market but were destroyed by the spread of *Fusarium* disease. This disease also impaired Taiwan's dominance in the export market in the 1980's. In Taiwan, high cost of production due to Foc has reduced the area from 40,000 hectares to 6,000 hectares in the 1970s..

Referring to panama disease (Foc), he highlighted that there are four known races of the disease, three of which attack one or more banana cultivars. Symptoms of the disease do not appear on young suckers. He also cautioned that at present there is no effective chemical control is available though effective control measures include planting in areas or fields that are not infested with this fungus, the use of disease-free propagation material, and the planting of cultivars with resistance to this disease. Plantains are seemingly resistant to this fungus.

The recent spread and epidemics of Tropical Race 4 of Panama Wilt in China, the Philippines, and other Asian countries have seriously affected the banana industry, especially the most commercially viable Cavendish variety.

The two types of Sigatoka disease , Black sigatoka and Yellow sigatoka caused by fungi *Mycosphaerella fijiensis* and *Mycosphaerella musicola,* respectively. He pointed out that warm temperatures, high humidity, and frequent rainfall are ideal for disease development and spread. Sigatoka does not kill the plant but causes premature defoliation, resulting to reduced crop yield. Generally Sigatoka affects fruit quality and productivity. Chemical control is the only major management strategy and represents major production cost (over US $ 300 million/yr). However, about 20% of production cost is spent on chemical control that requires about 50-65 applications a year. The fungicide is also applying as an aerial spray, leading to health and environmental concerns in many nations.

Dr. Mollina referred to MOKO and blood disease, caused by bacteria *Pseudomonas* spp, as the most dreadful diseases of banana, which cause the plant to wilt and leaves drying out. Fruit growth is stopped once infection occurs and young banana fingers become deformed, turn black, and shrivel up. Bananas near maturity may show no outward symptoms, but the inner pulp may be discoloured and decayed. There is no chemical control for this disease.

The Banana Bunchy Top Virus (BBTV), is also one of the most serious diseases of banana. Once established, it is extremely difficult to manage or eradicate. The mature plants infected with BBTV, bunch together at the top of the plant, the symptom for which this disease is named. The virus is spread from plant to plant by aphids and from place to place by people transporting planting materials obtained from infected plants. There is no cure for BBTV. Some banana varieties, like the Cavendish types, are more readily infected with the virus. No variety of banana is resistant at the moment. Banana plants that show symptoms rarely bear fruit. Because they are reservoirs of the virus, they must be destroyed.

Strength and extent of managing these diseases remain the most important challenge in banana industry producing countries. A lot of effort is being channelled on determining the geographic distribution of Foc Races, identifying quarantine policies, other effective disease management strategies, and also
seeking for global collaboration to address Foc in particular. Mitigating the threat of these diseases is a priority of this region.

3. PANEL DISCUSSION

Chaired by Yacob Ahmad- (TFNet)

Members:

1. Dr. Augustin Mollina – Bioversity, The Philippines
2. Dr. YI Gan-jun - Guandong Academy of Agricultural Sciences, China
3. Mr. Mokhtarud-din bin Husain (Department of Agriculture, Malaysia
4. Mr. Tengku Ab. Malik (MARDI, Malaysia)
5. Dr. Li Chun Yu- Guandong Academy of Agricultural Sciences, China
6. Dr. Christanti Sumardiyono - Universitas Gadjah Mada, Indonesia
7. Dr. Siti Subandiyah- Universitas Gadjah Mada, Indonesia

All the participants agreed that the demand for banana is growing locally and internationally. However the production is declining over the years due to the diseases. Experiences in Indonesia and Philippines have indicated that an area-wide control approach, diligent cultural practices, and optimum fertilizer application may delay and reduce the incidences of *Fusarium* wilt. With regard to the use of tissue culture as planting materials and their disease tolerance characteristics, there are differences in opinion among the researchers. Currently, the general consensus among the panel members is that the Cavendish variety is more susceptible to *Fusarium* wilt while cooking variety is more susceptible to MOKO and blood diseases.

With regard to biological control of *Fusarium* wilt disease, the Chinese experiences have indicated that crop rotation with *Allium* sp. may help to reduce the inoculums potential with regard to *Fusarium* wilt. However, more research work is needed to further convince the growers especially on the use of biological control methods by using crop rotation with *Allium* sp.

The Malaysian experiences of intercropping of banana with oil palm have shown delayed spread of *Fusarium* wilt. Intercropping could be another option for entrepreneurs who would like to embark on large scale banana cultivation in Malaysia and other countries.

As for the regional level, collaborative research, exchange of tolerant genetic materials, and cooperation in quarantine border control of vegetative plant materials need to be looked into for the long term benefit of the growers.

Finally, for Malaysia, a national task force consisting of scientists, agriculture officers and banana growers has to be set up to combat the banana diseases that ravaging the banana industry. The role of the task force is to monitor the spread, organizing area wide disease management and determining the disease control technique applicable in the specific areas. TFNet will initiate the setting up of this task force.

4. CONCLUSION

Workshop participants were given a scenario of the status of Panama (Fusarium) Wilt Disease and MOKO disease caused by *Pseudomonas* spp on bananas in China, Indonesia, Malaysia and the Philippines. The various containment measures such as biological control using Chinese leek, induced resistance against Fusarium Wilt and cultural methods practiced in the countries around the region were also discussed.

Concerned with the increasing incidences of these diseases, participants concurred that national initiatives as that practiced in Indonesia and China must be implemented to contain these diseases, especially Panama Wilt Disease.

The initiatives should include implementation of good cultural practices, eradication of diseased trees and burning and isolation of infected areas, use of disease free planting materials, encourage use of tissue cultured materials, disinfection of tools and equipment, planting of tolerant varieties, crop rotation and more research and development to reduce disease incidences.

The participants of the workshop felt that it was imperative to set up a National Banana Disease Task Force to monitor and coordinate operations and activities required for early detection that will mitigate incidences and spread of both these devastating banana diseases. The Task Force would also advise the agencies on methods and cultural practices to minimize crop damage.

5. APPENDIX

5.1. Welcoming and Opening Adresses

Welcoming address by TFNet CEO, Mr. Yacob Ahmad

Good Morning and Salam Sejahtera
My colleagues, YM Tengku Ab Malik Tengku Maamun, Director of Horticultural Research Center, MARDI
Tn HJ Mohd Yunus Ismail, Director, Plant Quarantine Division, Department of Agriculture
Distinguished guests,
speakers
Ladies and Gentlemen,

On behalf of the organizing committee, It is my pleasure to welcome you to the workshop on 'Integrated approaches to banana disease management'. I am glad that most of the stakeholders in the Malaysian banana industry including Government agencies, chemical companies, universities and the others in the private sector are present here today to discuss on a serious malady that are plaguing our banana industry.
From my last count more 70% Government agencies, Private sector 14% , university 9%. Even I'd love to have more from the private sector and universities.

Before I go on, for the benefit of those who are unfamiliar with International Tropical Fruits Network or TFNet, , I would like introduce you to what or who we are. please bear with me for a few minutes

International Tropical Fruits Network or better known as TFNet is an Intergovernmental and institutional Global Network, set up under the auspices of the Food and Agricultural Organisation (FAO) of the United Nations in 2000 and Malaysia has been the host since it was established. Our mandate is to promote sustainable development of the tropical fruit industry in relation to production, consumption and trade.

TFNet's activities include capacity building, project implementation, studies and consultancies.

TFNet is also membership based. We have three categories of memberships

That is country membership for countries, associate membership for institutions, associations, organizations etc and ordinary membership for any individual and non profit organization. There's a membership form in your folder if you are interested to be our member.

TFNet's main activities include capacity building and information dissemination.
For example, this workshop today is one of a series of workshops planned by TFNet for member countries. For your information, last October we organized a workshop on the value chain approach to enhance smallholders participation in Bandung, Indonesia and in December, in collaboration with FAO we organized a workshop in Kuala Lumpur on Small and medium Agroprocessing for 10 Asian countries. Next month we will be organizing one on the Tropical Fruit value chain in Lagos, Nigeria for 15 African countries.

The idea in this workshop, actually started from a discussion among friends in MARDI and DOA on the recent outbreaks of diseases on fruit crops such as banana and papaya. Feedback from the various states also showed that the local banana industry was threatened by 2 major diseases, the fusarium wilt and the moko disease. It was then decided that a workshop be held involving experts in the region to discuss on solutions to address the issue.

The workshop is also related to the last workshop organized by TFNet on dragonfruit or pitaya in 2008. During that workshop we invited experts from Vietnam to share their experiences on pitaya cultivation and disease management.

Similarly for this workshop, experts from China, Indonesia and the Philippines have been invited to present their research work and experiences in minimizing occurrences of banana diseases.
we have to admit that it is a big challenge trying to contain diseases like fusarium wilt or moko disease, however, I think interactions like today can provide us some directions.

There will be 8 presentations today. With the DOA introducing the status of banana diseases in country followed by the research direction by MARDI to improve the disease situation, and speakers from the China, Indonesia and the Philippines, will discuss on some areas of research and preventive measures carried out in the respective countries.

We will then later have a panel discussion to deliberate on related issues and at the end of the day we hope to come up with some recommendations to the Agricultural Ministry on possible ways to manage these diseases.

I would like to take this opportunity to thank our collaborators MARDI and Department of Agriculture for their support, contributions and seriousness in organizing this workshop.
I would like to thank the speakers who are here to sharing their knowledge and experiences
Thank you to members of the organizing committee of which without them this workshop would not have been possible..
And lastly, thank you to all participants for being part of the workshop. We look forward to your indulgence in this workshop.
Thank you very much.

Opening Speech by Secretary General, Ministry of Agriculture and Agro-based Industry, Malaysia
Delivered by:
YM Tengku Ab. Malik Tengku Maamun, Director, Horticultural Research Center, MARDI

Mr. Yacob Ahmad
Chairman of the Organising Committee
Chief Executive Officer
International Tropical Fruits Network (TFNet)
Tn HJ Mohd Yunus Ismail, Director, Plant Quarantine Division, Department of Agriculture

Distinguished speakers and guests

Ladies and Gentlemen

Selamat Pagi and Good Morning

I would, first of all, like to thank the organizers – MARDI, Dept. of Agriculture and TFNet, for giving me the honor to officiate this very important workshop with the theme 'Integrated Approaches in Banana Disease Management'. I also would like to extend a very warm

welcome to all speakers, guests, foreign participants and everyone in this hall, who are here to attend this workshop.

Ladies and Gentlemen,

Banana is a crop that feeds the poor in the developing world's and the well to do in the developed world in its fresh or processed form. It contributes as principal source of food, nutrition and cash income.

Banana is also the most popular tropical fruit besides melons, citrus, pineapple, papaya and avocado. The world production of banana in 2008 was estimated to be around 90.7 million tonnes, compared to the major tropical fruits such as mango, pineapple, papaya and avocado which totaled 66.4 million tonnes for the same year. The major banana producers are India, The Philippines, China, Equador, Brazil and Indonesia. Banana is also the most exported fruit with an export value of an estimated USD 7.2 billion in 2007, compared to USD 1.5 billion for pineapple and USD 1.4 billion for mangoes. The main exporters were Ecuador, Costa Rica, Philippines and Colombia.

The main banana variety traded is the cavendish variety, which has been grown in Malaysia since the 1990's. The commercial growing of Cavendish banana in Malaysia, however has been adversely affected by the outbreak of diseases, especially the panama disease or fusarium wilt. Since the 1990's ,there have been examples of large scale cultivation of the Cavendish variety which, could not sustain due to losses caused by fusarium wilt.

The Fusarium wilt disease manifests itself in most Asian countries, and managing the diseases remains a key factor to sustain the banana industry. Besides the cavendish, the disease also attacks other banana varieties such as Berangan and Mas. Recently another disease which affects cooking banana has been identified. The disease called MOKO disease, is caused by a bacterium Ralstonia spp. It is now a major threat for cooking bananas in Malaysia and the region.

Ladies and Gentlemen,

The NKEA listed banana as one of the potential fruit crops to be developed for export. The objectives of the NKEA will only be on paper, if fundamental issues regarding upstream activities along the banana value chain are not addressed. Pest and diseases incidences in banana are now a big issue, and steps including the dissemination of information on their management is imperative.

In this regard, I am happy that the organizers of this workshop have invited the 'who is who' in the banana fraternity specially on diseases to present, discuss and share the various efforts executed especially in China, Indonesia and the Philippines to manage banana diseases.

Ladies and Gentlemen

I understand that for this workshop, there will be 8 presentations from experts from China, Indonesia, the Philippines and Malaysia. I sincerely hope the interactions expected in this workshop will be of use to all participants and at the same time will give opportunities to establish networking ties for knowledge exchange and future collaboration.

Before I conclude, I would like to commend the organizers International Tropical Fruits Network, MARDI and the Department of Agriculture, for their initiatives in organizing this very timely workshop. Finally, I wish everyone a successful and fruitful deliberation, and at the end of the day, I hope some guidelines can be drafted out for a practical approach to deal with banana disease problems in Malaysia and the region` in general.

On this note, I have great pleasure in declaring open the workshop on 'Integrated approaches in Banana Disease Management'.

Thank you.

5.2. Workshop Program

Date	Time	Programme
DAY 1		
	0800 - 0900	Registration of Participants
	0900 - 0930	Workshop Official Opening - Welcome address by Chairman of the Organising Committee - Welcome and opening address by Y.Bhg. Dato' Mohd Hashim bin Abdullah Secretary General, Ministry of Agriculture and Agro-based Industry, Malaysia
	9.30 - 1000	Tea / Coffee break
	1000 - 1030	Paper 1: Status of banana cultivation and disease incidences in Malaysia - Mr. Mokhtarud-din bin Husain, Department of Agriculture, Malaysia
	1030 - 1100	Paper 2: Status of banana diseases research in Malaysia - Y.M. Tengku Ab. Malik bin Tengku Maamun, MARDI, Malaysia
	1100 – 1130	Paper 3: Integrative approaches for managing banana fusarium wilt in China - Dr. Li ChunYu, Fruit Tree Research Institute, GAAS, Guangzhou, China
	1130 - 1200	Paper 4: Induced resistance of banana against fusarium wilt - Dr. Christanti Sumardiyono, Universiti Gadja Mada, Indonesia
	1200 - 1230	Paper 5: Integrated management of banana diseases in Indonesia - Dr. Siti Subandiyah, Universiti Gadja Mada, Indonesia
	1230 - 1400	Exhibits and Lunch
	1400 - 1430	Paper 6: Banana diseases: Continuring major production constraint and R & D challenges in Asia. - Dr. Agustin Mollina, Bioversity International, Philippines
	1430 – 1500	Paper 7: Performance of organically grown banana in China - Dr. Yi Ganjun, Fruit Tree Research Institute, GAAS, Guangzhou, China
	1500 - 1630	Panel discussion
	1630	Tea / Coffee break

5.3. List of participants

1	Noor Zikri B. Mohb. Noor	Agricultural Chemicals (M) Sdn. Bhd.
2	Norani Bin Jaffar	Agricultural Chemicals (M) Sdn. Bhd.
3	Billy Teoh Cheng Lee	Bayer Co. (M) Sdn Bhd
4	Nilawati Binti Pilus	Department of Agriculture
5	Atikah Bt. Abdul Kadir Jailani	Department of Agriculture, Crop Protection & Plant Quarantine Division
6	Haji Mohd. Yunus Bin Ismail	Department of Agriculture, Crop Protection & Plant Quarantine Division
7	Ho Haw Leng	Department of Agriculture, Crop Protection & Plant Quarantine Division
8	Jatil Aliah Timin	Department of Agriculture, Crop Protection & Plant Quarantine Division
9	Mohd. Redzuan Bin Suddin	Department of Agriculture, Crop Protection & Plant Quarantine Division
10	Noorohaida Bt. Mohd. Yunus	Department of Agriculture, Crop Protection & Plant Quarantine Division
11	Robert William Wilfred	Department of Agriculture, Crop Protection & Plant Quarantine Division
12	Sabariah Kamis	Department of Agriculture, Crop Protection & Plant Quarantine Division
13	Yusof Bin Othman	Department of Agriculture, Crop Protection & Plant Quarantine Division
14	Zulhisham Bin Jusoh	Department of Agriculture, Crop Protection & Plant Quarantine Division
15	Ahmad Kamil Moho Yunus	Department of Agriculture, Crop Protection, Johor
16	Rohaina Mat Nawi	Department of Agriculture, Crop Protection, Kedah
17	Mat Jusoh Ab. Latif	Department of Agriculture, Crop Protection, Kelantan
18	Rusdan Aboul Talib	Department of Agriculture, Crop Protection, Melaka
19	Hafizrahimi Bin Othman	Department of Agriculture, Crop Protection, Negeri Sembilan
20	Abdullah Shuhaimi Bin Abdul Malek	Department of Agriculture, Crop Protection, Pahang
21	Norsiyenti Dthman	Department of Agriculture, Crop Protection, Perak
22	Nilainati Pilus	Department of Agriculture, Crop Protection, Perlis
23	Muhammad Dzulkefli Bin Alwi	Department of Agriculture, Crop Protection, Pulau Pinang
24	Misrudin Hadis	Department of Agriculture, Crop Protection, Selangor
25	Zazali Chik	Department of Agriculture, Crop Protection, Terengganu
26	Abesah Ali	Department of Agriculture, Horticulture Division
27	Ashraf Salehudin	Department of Agriculture, Horticulture Division
28	Dayang Masrizah Awang Tengah	Department of Agriculture, Horticulture Division
29	Gan Hwee Yiam	Department of Agriculture, Horticulture Division
30	Hasnah Arbaean	Department of Agriculture, Horticulture Division
31	Hj. Azmi Daud	Department of Agriculture, Horticulture Division
32	Khazana Ibrahim	Department of Agriculture, Horticulture Division
33	Kwan Lan Ching	Department of Agriculture, Horticulture Division
34	Lem Ming Siang	Department of Agriculture, Horticulture Division
35	Mohd. Ali Hanafiah Mazlan	Department of Agriculture, Horticulture Division
36	Murugan Subramaniam	Department of Agriculture, Horticulture Division
37	Nur Mala Asyikin Abdul Wahab	Department of Agriculture, Horticulture Division
38	Nurashikin Abdul Razak	Department of Agriculture, Horticulture Division
39	Rohaya Yahya	Department of Agriculture, Horticulture Division
40	Rozianti Bt Ali	Department of Agriculture, Horticulture Division
41	Ting Ping Ping	Department of Agriculture, Horticulture Division
42	Wan Mohammad Zukarnain Baharudin	Department of Agriculture, Horticulture Division
43	Azmi bin Mahmood	Department of Agriculture, Kedah

44	Siti Mardina binti Ismail	Department of Agriculture, Kedah
45	Lee Sim Huat	Department of Agriculture, Labuan
46	Azmy B Mat	Department of Agriculture, Melaka
47	Mohd Nazri Bin Abd Rahman	Department of Agriculture, Perak
48	Noor Sham Bin Abd. Aziz	Department of Agriculture, Perak
49	Ili Safuraa Binti Othman Ghani	Department of Agriculture, Pesticides Control Division
50	Nur Amalina Binti Omran	Department of Agriculture, Pesticides Control Division
51	Rohaya Binti Mat Nor	Department of Agriculture, Pesticides Control Division
52	Abdul Hamid Bin Tahir	Department of Agriculture, Pulau Pinang
53	Abdul Rani Bin Hasan	Department of Agriculture, Pulau Pinang
54	Muhammad Sayyid Suffi Bin Ismail	Department of Agriculture, Pulau Pinang
55	Razali Bin Muhammad	Department of Agriculture, Pulau Pinang
56	Sulaiman Bin Salleh	Department of Agriculture, Pulau Pinang
57	Zarina Bt Ramli	Department of Agriculture, Pulau Pinang
58	Hj. Ruslan Bin Hj. Alidin	Department of Agriculture, Sabah
59	Jabi Bin Tananak	Department of Agriculture, Sabah
60	Suffian Bin Muhamad	Department of Agriculture, Sabah
61	Lai Lee San	Department of Agriculture, Sarawak
62	Lily Eng	Department of Agriculture, Sarawak
63	Abd Husin Bin Abd Hamid	Department of Agriculture, Selangor
64	Emy Faizal Bin Mohd Borham	Department of Agriculture, Selangor
65	Hanifah Bin Hassan	Department of Agriculture, Selangor
66	Misban Bin Ridzuan	Department of Agriculture, Selangor
67	Mohd Fairuz Afendy Bin Md. Isa	Department of Agriculture, Selangor
68	Mohd Suhaimi Bin Abd Hamid	Department of Agriculture, Selangor
69	Yahya Bin Khashim	Department of Agriculture, Selangor
70	Zainal Abidin Bin Sulaiman	Department of Agriculture, Selangor
71	Ismail Bin Hashim	EPA Management Sdn. Bhd., R&D Dept
72	Mardian Bin Matasan	EPA Management Sdn. Bhd., R&D Dept
73	Siti Murni Binti Amat Khalid	EPA Management Sdn. Bhd., R&D Dept
74	Zainuriah Binti Abdullah	EPA Management Sdn. Bhd., R&D Dept
75	Jamal Abdul Nasir Mohd Lajin	Felda Agricultural Services Sdn. Bhd.
76	Roslan Sulaiman	Felda Agricultural Services Sdn. Bhd.
77	Samsudin Tasrif	Felda Agricultural Services Sdn. Bhd.
78	Then Kek Hoe	Felda Agricultural Services Sdn. Bhd.
79	Roslan bin Sidek	FELDA, Jengka
80	Md. Yusof bin Mee	FELDA, Kuantan
81	Mohd. Alias bin Loman	FELDA, Kuantan
82	Othman bin Muhamad	FELDA, Kuantan
83	Zahidin bin Ali	FELDA, Kuantan
84	Abd. Jalil bin Jamaludin	FELDA, Mempaga
85	Md. Zain bin Mahmood	FELDA, Mempaga
86	Sani bin Abdul Rahman	FELDA, Mempaga
87	Shafiee bin Ahmad	FELDA, Mempaga
88	Arif Syafwan bin Muhamad	FELDA, Perkebunan & Hal Ehwal Tanam Semula

89	Arzami bin Hashim	FELDA, Perkebunan & Hal Ehwal Tanam Semula
90	Intan Suhana bt Misman	FELDA, Perkebunan & Hal Ehwal Tanam Semula
91	Mohd. Nazri bin Jamaludin	FELDA, Perkebunan & Hal Ehwal Tanam Semula
92	Mohd. Saidiee bin Salleh	FELDA, Perkebunan & Hal Ehwal Tanam Semula
93	Fan Jian Wenn	Focus Horticulture Sdn Bhd
94	Lo Nyok Piang	Halex Corporation
95	Md. Yusof Hussein	Hexagon Green Sdn. Bhd.
96	Noraini Samad	Hexagon Green Sdn. Bhd.
97	Ng Kwang Yew	Hextar Chemicals
98	Siti Aminah binti Sudin	Hextar Chemicals Sdn Bhd
99	Marina Quek Min Choo	Kenso Corporation (M) Sdn. Bhd.
100	Ng Chee Yean	Kenso Corporation (M) Sdn. Bhd.
101	Abd Halim Mat Zain	MARDI
102	Abdul Halim Bin Mat Zain	MARDI
103	Ahmad Hafiz Bin Baharom	MARDI
104	Chong Tet Vun	MARDI
105	Maimun Tahir	MARDI
106	Maya Izar Bt. Khaidizar	MARDI
107	Mohd Khairulazhar Bin Mokhtar	MARDI
108	Mohd Nazarudin Anuar	MARDI
109	Mohd Shaib Jaafar	MARDI
110	Mohd Shamsudin Osman	MARDI
111	Mohd. Shaib Bin Jaafar	MARDI
112	Mohd. Suhaimi Alias	MARDI
113	Siti Noraini bt Bunawan	MARDI
114	Suhanna Binti Ahmad	MARDI
115	Umikalsum Mohamed Bahari	MARDI
116	Zulkefli Abd Rahman	MARDI
117	Zulkefli Malik	MARDI
118	Anuar Bin Hassan	MARDI, Negeri Johor
119	Hj. Ahmad Bin Ab Majid	MEGArancang
120	Ahmad Rafiq Bin Abdullah	NATC, MOA
121	Che Zaim Bin Zahari	NATC, MOA
122	Nor Haliza Binti Abas	NATC, MOA
123	Shamsudin Bin Che Lah	NATC, MOA
124	Syazwani Binti Mohd Anuar	NATC, MOA
125	Natallie Hon	Nufarm Asia Sdn Bhd
126	Heng Wan Joo	Nufarm Malaysia Sdn Bhd
127	Laith Khalil Tawfeeq	Plant Diseases and Control, School of Biology Science,USM, Iraq
128	M Azmi bin Mohd Mohid	RISDA
129	Saidah bt Ahmad	RISDA
130	Lau Boon Seng	Syngenta Crop Protection Sdn Bhd
131	Jeremy Ngim	Syngenta Crop Protection Sdn. Bhd.
132	Tong Yew Wai	Syngenta Crop Protection Sdn. Bhd.
133	Fauziah Ismail	UITM SHAH ALAM

134	Mohammad Feizal Daud	UITM SHAH ALAM
135	Ho Shui Hing	United Plantations Berhad
136	N. Heamaashini	United Plantations Berhad
137	Afifah Aini Binti Burhan	Universiti Putra Malaysia
138	Dzarifah Mohamed Zulperi	Universiti Putra Malaysia
139	Sariah Meon	Universiti Putra Malaysia
140	Wong Mui Yun	Universiti Putra Malaysia
141	Erneeza Mohd Hata	UPM
142	Kamaruzaman Sijam	UPM
143	Rosli Mohamad	UPM
144	Siti Nur Sarah Shafiei	UPM
145	Yahya Awang	UPM
146	Hidayah Jasmi	UPM, Institute of Tropical Agriculture
147	Dr. Gurmit Singh	Pantropical Agricultural Services Sdn. Bhd

5.4. Presentations