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HOW DOES MOKO DISEASE OR BACTERIAL WITHER OF BANANA PLANTS?

By

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High temperatures and moist soils are favourable to *R. solanacearum*. It can also be found in a variety of soil types and pH levels. Regarding the planning of measures to address the issue of this bacteria found in nursery areas, the USDA (United States Department of Agriculture) states that these bacteria can be moved from one place to another through the soil, contaminated irrigation water, tools that have not been aseptically cleaned (Disinfection), or personal belongings. It can also be spread easily through tree transplants and seeding from trees infected by this bacterium. In addition, this bacterium can move to other banana trees through agricultural equipment such as hoes, machetes, knives and others. The equipment used on banana trees that have been affected by the disease will bring the bacteria together if not cleaned aseptically. Aseptically means killing germs either by heating (given a high temperature) or by washing and rinsing with an antibacterial solution such as Dettol or Clorox.



Figure1. The picture shows bananas suffering from the Moko disease

Currently, bacterial wilt disease, of the known as Moko disease, has infected the majority of banana trees. Farmers and businesses that handle bananas suffered significant losses as a result of the disease since they were unable to sell the banana-related goods. Bananas affected by this plant will be completely damaged. Banana Moko Disease or better known as Banana Plant Bacterial Wilt Disease is a disease caused by *Ralstonia solanacearum* bacterial infection. This bacterium is found in the soil and it can live on the host for 2 to 3 years. *R. solanacearum* is a gram-negative bacterium and it grows aerobically (requires air) and does not produce spores. According to Stevenson (2001), bacterial growth in Broth culture can be inhibited by salt solution (NaCl) with a concentration of more than 2%. This bacterium does not only attack banana trees, but it also attacks other trees such as tomatoes, potatoes, eggplant and tobacco. These bacteria are usually found in tropical, subtropical and some temperate regions of the world.

WHAT IS THE CAUSE OF THIS DISEASE?

Is an outbreak of Moko Disease to blame? Other illnesses or banana blood disease (BDB)? What other small farmers and owners of banana plants serve as agricultural development agents? The records show that the banana plant is a popular fruit plant grown in Malaysia for the domestic market and export. The area of banana cultivation is recorded as the second highest with an area between 27,454 ha and an area of 33,495 ha per year according to the statistics of the Malaysian Department of Agriculture (DOA) from 2009 - 2013 with the respective production estimated between 279,762 up to 357,745 t/year.

In 2018, it was reported to be 35,156 hectares with a yield of 376,690 metric tons (Source: Fruit Crop Statistics Booklet, Department of Agriculture Malaysia 2018). In Malaysia, reports are stating that both groups of bananas are planted for 'fresh eating' and 'for processing' planted almost throughout the state. From the above data, the blogger also found that the area of planting and yield of bananas has increased when wilt and Moko diseases have been curbed with several methods in a relatively long period (2018 - 2006 = 12 years passed).

Among the types of bananas in the 'for processing' group that are planted are "*Nangka, Nipah, Tanduk, Raja Lang* and *Awak- Awak*" bananas while the bananas in the 'fresh eating' group are "*Berangan*", *Cavendish, Rastali* and *Mas* bananas. Currently, almost 50% of the area of all banana crops in the country is planted with Chestnut and Cavendish bananas. Since the attack of bacterial wilt disease began to attack banana plants in 2007 in Johor (It was identified in 2006 in Johor) then it was reported that almost 60.7% of banana areas were reported to be infected with this disease. The Department of Agriculture first discovered this bacterial wilt disease, which is also known as Moko Disease and is caused by the bacterium *Ralstonia solanacearum*. Additional research into the disease's identity revealed that the bacterial wilt disease on bananas in this nation isn't caused by the Moko sickness but rather by Blood Disease on bananas, which is caused by Blood Disease Bacterium (BDB). Nevertheless, because the expansion agent mentioned that those were the signs of Moko's condition, more people are aware of them. Regarding Moko banana sickness assaults, I've written a lot.

Regarding the background of the origin of BDB Disease, it was first reported in 1906 in the Saleiran Islands, Sulawesi, Indonesia. This bacterial infection was reported to be so serious in 1916 that the plantation had to be left empty. In the early 1920s, it was reported that this disease began to spread to South Sulawesi and infected the "*Kepok*" banana cultivar (We call it "*Kapok*" Banana - same as "*Nipah*" banana) which is a local type of banana and also some wild banana species. At that time, it was reported that this type of bacteria was known as *Pseudomonas celebensis* and later identified as a species of *Xanthomonas spp.*

Recent reports have confirmed that this pathogen is one of the strains in the *Ralstonia solanacearum* species complex, but different phytotypes (Phytotypes) compared to the pathogen that causes Moko disease. The symptoms of this disease look like the symptoms of Moko disease, but it was found that the host is limited to banana plants only and does not attack other plants such as plants from the Solanaceae family that can be attacked by Moko disease. The disease that was initially limited to a few areas in Indonesia is now reported to have spread to other areas. In Malaysia, there are initial reports that this disease has spread in the states of Johor, Perak, Melaka, Negeri Sembilan, Penang, Kedah, Selangor and Sarawak. The Department of Agriculture always reports the presence of this disease systematically and tries to control it through a Special Committee in the Plant Biosecurity Division.

Anyhow, everyone must be aware of any signs of blood disease or banana blood disease. Banana (BDB) displaying Moko disease-like symptoms. The young leaves will display indications of yellowing and pale, rolled, necrotic, and drying leaves as the young shoots begin to wilt. Finally, the tendrils will wither and die and bananas that are attacked in the early stages of growth will be stunted, ripen early and rot. Although the fruit produced looks normal on the outside when cutting the inside looks rotten, reddish yellow and rotting. The fruit stalk changes colour, and the male flower which is the heart of the banana becomes rotten, watery, and damaged. The vascular tissue will appear blackish rot and when the tree trunk is cut transversely, there are brownish-red stripes detected on the vascular tissue. If soaked in water, the trunk of the infected banana tree will release a white liquid or ooze that looks like milk (Figure 1). The attacked tree will eventually wither and die. The spread of this disease can occur in bananas grown in areas where the soil and water sources are contaminated with these bacteria. This infection can also occur through agricultural tools or machinery and through insects that land on male flowers that have been infected with the disease and then land on the flowers of other banana plants.



Figure 2. The picture shows the effects of banana trees suffering from Moko disease

Here are some of the symptoms that occur as a result of the attack of *R. solanacearum* on banana trees (Figure 2).

- a) **Vascular tissue becomes brown and black.**
- b) **The presence of ooze bacteria on the stem/rhizome when it is cut.**
- c) **Fruit becomes damaged and then black and rotten**

The symptoms seen here are the consequence of an attack by the *R. solanacearum* bacteria, which can enter the banana tree through an external or natural lesion in the tree's trunk. Natural wounds are frequently caused by root development and external trauma, such as when farmers use unwashed machetes or knives during agricultural techniques. The bacteria contained in the xylem will cause the banana tree to experience many problems such as water not reaching the fruit area, wall degradation and wilting resulting from lack of water. As a result, these problems, causes damage to the leaves (withered) and also the fruit (damaged).

STEPS TO DEAL WITH THE PROBLEM OF BANANA MOKO DISEASE

The attack of this disease is like cancer that humans suffer from, it has certain stages where at a critical stage, this tree cannot be treated anymore and needs to be removed and destroyed. In the initial stage, the oldest leaves start to wither and in the next stage, it will attack the young leaves. The tendrils of this banana tree will also be damaged and die if the concentration of bacteria is high in the tree. As a result, bananas become infected with bacteria, become stunted, rot and eventually rot. Until now, there is no specific treatment that can cure the infection of this disease other than destroying all the infected trees and then implementing Good Agricultural Practices (APB).

Farmers are encouraged to create a crop cycle and not plant banana trees for several years. Farmers need to destroy all infected banana trees and nearby trees. These areas need to be quarantined for 18 to 24 months to reduce bacterial growth in the soil. The destruction of banana trees infected with Moko disease is appropriate to ensure that banana trees are no longer attacked by the disease. However, in reality, it is difficult to practice because the bacteria will appear and multiply again in the future.

This is because small bacterial colonies will grow a lot if the food available to them is sufficient for that growth. In addition, the income of farmers and banana tree operators will decline and suffer losses and some will lose their livelihoods due to relatively high cleaning costs and decreased sources of income. In addition, the price of bananas will skyrocket and will make it difficult for banana-based traders. Many more negative effects will occur if this method of control is practised. Therefore, to treat this disease, we must scientifically understand the cause and mechanism of this infection. This understanding is very necessary because the infection of Moko disease is the same as the infection of cancer in humans.

If a cancer sufferer has been diagnosed at an early stage, it can be treated and if it has reached a critical stage, it cannot be treated but the cancer infection can be prevented. Just like Moko's disease infection, it is preventable and treatable. Prevention can be done by killing *R. solanacearum* bacteria in the soil and practising Good Agricultural Practices for new planting of banana trees or after the infected banana trees are destroyed. Treatment can be given to banana trees infected with Moko disease at an early stage by killing the bacteria in the soil and providing sufficient nutrients to the banana trees. Killing the bacteria is not enough to restore the tree to good condition but by obtaining enough nutrients, the tree can become healthier and able to resist disease.

TREATMENT CONCEPTS

In dealing with the problem of Moko disease on banana trees, there are two important and effective methods and concepts, which are prevention methods and treatment methods.

The prevention method starts with the level of land preparation for banana planting or banana replanting due to the attack of this disease. The treatment method is done for trees that have just shown the initial symptoms of Moko disease. According to the Department of Agriculture regarding the way to deal with the problem of Moko disease, they suggest that the banana trees that have been affected by the disease be eliminated in their entirety and leave the land without crops for several years. Although this method may be effective in dealing with this problem, they do not state how to kill *R. solanacearum* bacteria in soil that has been infected with Moko disease. These bacteria can live in the soil and multiply for a long time because the food available is sufficient for the growth of the bacteria. These bacteria need air (aerobic), carbon and nitrogen sources and also water to live. These bacteria will always be in the soil even if there are no banana trees in the soil.

Therefore, these bacteria will reappear if bananas are planted after 2 or 3 years of this soil being left and the same problem, Moko disease, will attack the banana trees again. As a result, in this case, it's crucial to make sure that *R. solanacearum* bacteria can be totally eliminated on the infected soil site after the Moko disease-affected trees are destroyed or at the start of the banana plant. One of the ways to kill these bacteria is killed or prevented from multiplying widely is by using a mixture of good bacteria. These good bacteria have the same basic properties as *R. solanacearum* bacteria where they need food to reproduce or grow or multiply bacterial colonies. The foods that are needed are such as oxygen, carbon sources from organic matter, nitrogen sources, and sources of trace elements such as trace metals and water. When the amount of beneficial bacteria outweighs the amount of *R. solanacearum* bacteria, the latter will struggle to find food since they must compete with the beneficial bacteria to survive.

R. solanacearum bacteria are thus eventually unable to reproduce and expand perfectly until these bacterial cells vanish from the soil and the soil is finally controlled by beneficial bacteria. Replanting a banana tree with *R. solanacearum* bacteria will not allow the bacteria to survive since they will have to compete with the beneficial bacteria for food. This is the concept of prevention that can be done to ensure that *R. solanacearum* bacteria that bring Moko disease to banana trees no longer grow after new planting or replanting on soil infected with the infection.

Therefore, before planting banana trees, it is advised that the land or the hole made for planting banana trees be watered with M-ProBio. In addition, in the prevention concept as well, banana farmers are advised to carry out Good Agricultural Practices (APB) recommended by the Department of Agriculture. Because the infection of Moko disease is also transmitted through carriers such as agricultural equipment used (machete, knife, hoe etc.), this equipment needs to be washed with bacteria killers such as Dettol or Clorox antiseptics. Washing or soaking these tools in an antiseptic will kill the bacteria and further prevent other trees from being infected by the *R. solanacearum* bacteria.

The second approach is the concept of treating banana trees infected with the Moko disease. This banana's Moko infection may be compared to a human cancer infection in that different stages of Moko disease infection exist depending on the symptoms that the affected tree exhibits. To ascertain the severity of the illness, trees with this virus must first be identified. If the trees have already reached a critical level, they must be removed, and replanting must be done while taking into mind the already described notion of prevention. At this crucial point, the fruit has been harmed, the tree's trunk has become black, and the leaves have dried and withered.

CONCLUSIONS

Treatment of banana trees infected with Moko disease depends on the level of the infection. If a tree exhibits all of the signs of Moko disease, it must be cut down and preventative measures must be taken. If there is one infected tree in a clump, the infected tree is destroyed, and treatment is given to other trees in the clump. The preventative and treatment strategies are the same, but the frequency is increased to as much as once per month until the tree has fully recovered. The effectiveness of this treatment is expected to be shown within 6 months of the first treatment.