Mango Malformation Disease (MMD) and Witches Broom (WB); Comparison of Etiology, Biology, Symptomology and Management

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SUMMARY

1. Objectives

The major objectives of the project were to summarize aspects of epidemiology and management of Mango Malformation Disease (MMD) caused by the fungus *Fusarium*, and the interaction of disease with the mango bud mite, *Aceria mangiferae*, causal agent of Witches Broom (WB). ha) en yema madura, inicio y plena floración y amarre de fruto en árboles de mango Tommy Atkins'.

2. Importance of the problem and impact on the mango industry.

Mango malformation is one of the most destructive diseases of this crop. Mango malformation disease (MMD) does not cause mortality of trees or other plant structures, however, it affects inflorescences and vegetative parts of the plant. Fruit yield may be drastically reduced, resulting in significant economic losses (Figure 1).

Figure 1. Mango trees severely infected with malformation disease.

MMD occurs in most mango producing countries worldwide and is caused by species of the fungal pathogen *Fusarium*. Airborne conidia of the pathogen are the infection structures by which the pathogen causes disease penetrating the plant tissue via apical and lateral buds and remain dormant until bud break. No systemic infection takes place, only local colonization of the bud tissues which are malformed (Figure 2).

When infected buds break, malformed vegetative and inflorescences are produced. Although the mango bud mite, *Aceria mangiferae*, has been suspected as a causal agent of MMD, different symptoms (Figure 3) are caused by this pest in mango, termed "Witches Broom" (WB). However, exacerbation of MMD symptoms can take place following wounding of bud tissues by the bud mite, allowing penetration of the fungus at these locations.

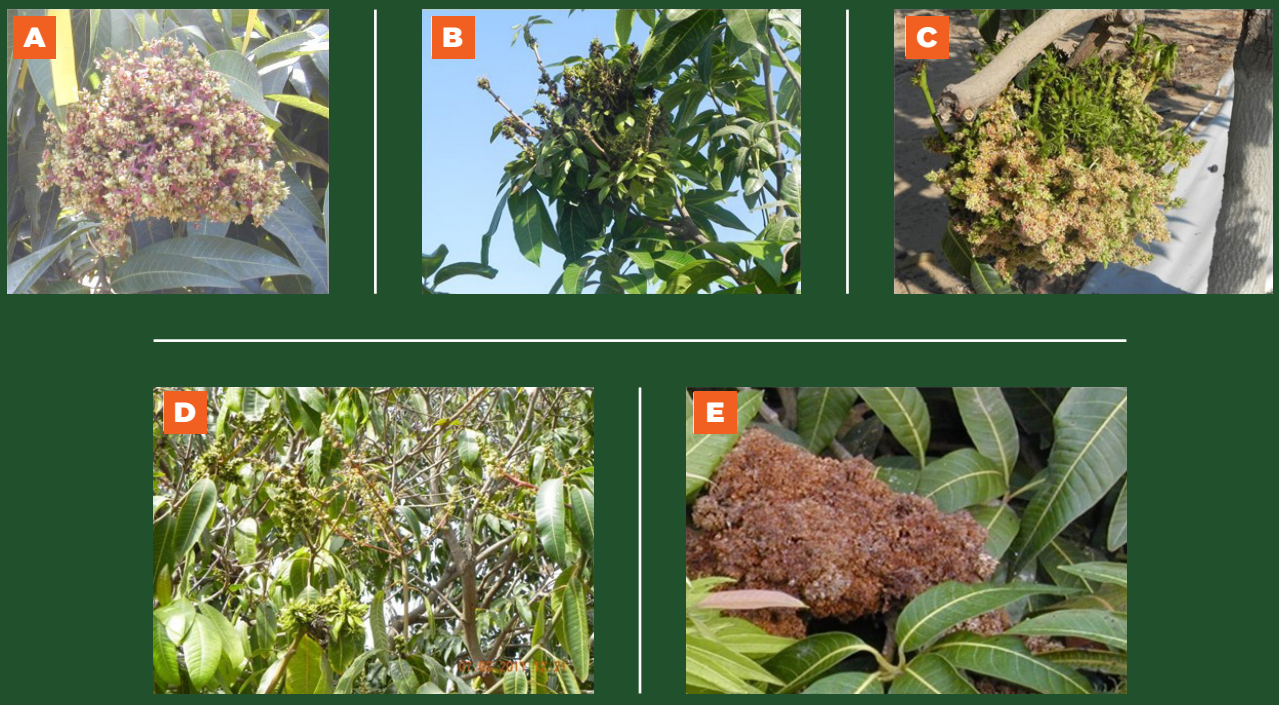

Figure 2. Symptoms of malformed inflorescences include a compact form with thick, green/red fleshy panicles that resemble cauliflowers **(A)**; a loose form with an open larger than normal inflorescences, but with thick secondary branches resembling a "witches broom" **(B)**; a combination of various compact and loose forms of vegetative and floral symptoms **(C and D)**; black masses of malformed panicles that can persist on the tree **(E)**.

3. Results and recommendations.
A strategy was developed for management of disease by elimination of the major inocula (conidia) sources of infection, i.e. malformed panicles, by pruning. Thereafter, subsequent fungicidal sprays are applied to protect and cure affected buds from infection via airborne conidia. Whether, and under what circumstances, the mite plays a role in spreading MMD among trees and orchards in other mango-production areas should be determined due to the potential impact these factors would have on MMD management strategies.economic losses (Figure 1).

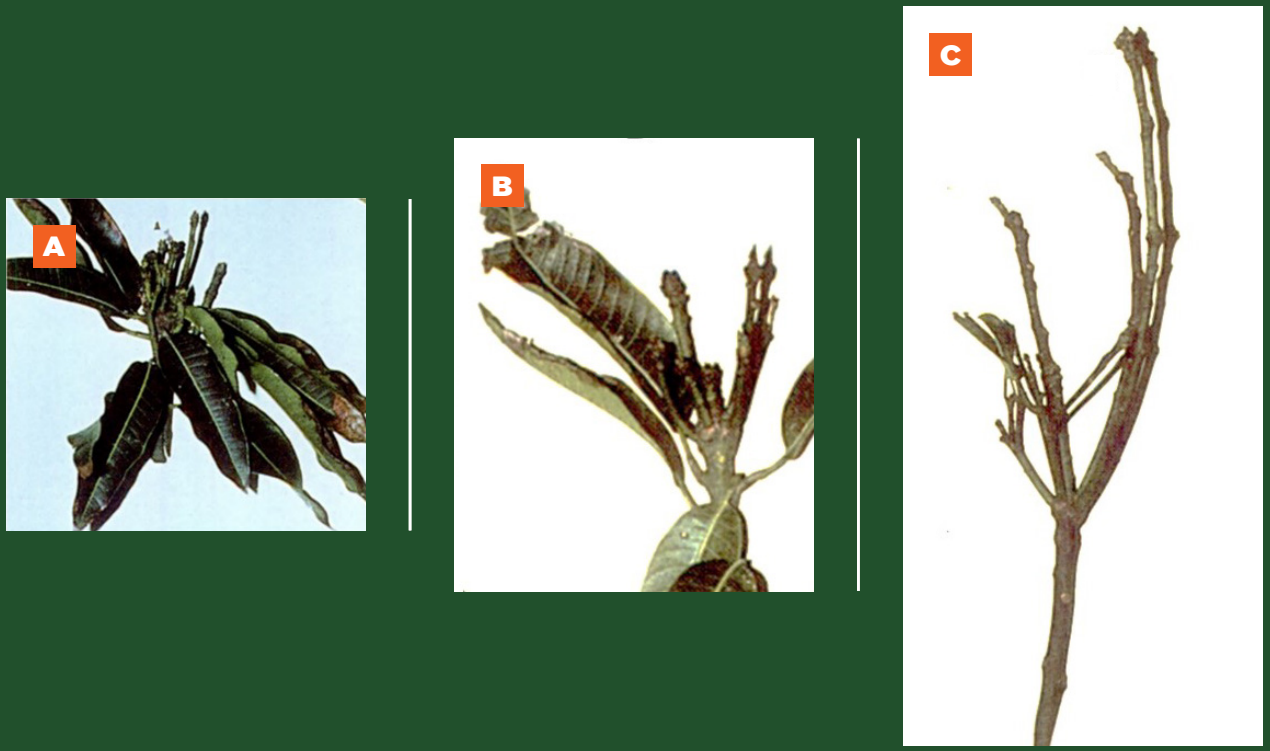

Figure 3. Typical "witches broom" symptoms of mango, caused by the mango bud mite, *Aceria mangiferae*. **A.** Drying of terminal buds, stunting of vegetative growth, dieback of floral panicles with necrosis of bud tissues and gall formation; **B.** Distorted growth terminals with arrested growth, short stunted young stems close together at the terminal branch; **C.** Leaf fall resulting in sparse growth of twig-like branches including stubby, short vegetative branches with discolored buds.

4. Future studies.

Etiology of the causal agents of disease.
Progress in several different areas of research may depend on identifying which *Fusarium* species cause MMD in different regions. The ability to identify different MMD agents would be needed to develop reliable disease diagnostics, as well as understand the diseases' etiology and epidemiology in different environments and improve MMD management strategies.

Management of MMD.
Infection by *F. mangiferae* is not systemic and the most susceptible organ of infection is the apical meristem. These critical data have helped develop an integrated strategy to manage MMD, but the timing of fungicide applications has not yet been optimized. Additional data that are required for optimization of the spray regime should address weather conditions that impact dissemination and germination of conidia, and their infection of the host. In the tropics, where flowering is erratic and often synchronized chemically, integrated MMD management could be adapted. Although malformed panicles are burned in some areas, this may not be possible where the practice is strictly regulated due to fire hazard and concerns about air pollution. Thus, alternative treatments, such as solarization, may be considered, whereby eradication of inocula from pruned infected panicles should be assessed.

New generation fungicides for MMD field control and infected budwood curing.
"New generation" fungicides should be assessed to screen *F. mangiferae* and other *Fusarium* species isolates in plates to determine efficacy in vitro. Then, evaluate the most effective compounds in field experiments to determine efficacy for control of MMD. In addition, develop a treatment using these new fungicides to eliminate the pathogen and cure infected budwood collected from heavily affected orchards.

Screening for MMD resistance.
Rootstocks, wild mango species (for breeding purposes) and current cultivars should be screened for susceptibility/tolerance/resistance with representative isolates of *F. mangiferae*. The protocol entails artificial inoculation of buds before floral initiation and assessment of MMD incidence, vegetative and inflorescence, after bud break.

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