THE THREAT OF CITRUS GREENING DISEASE (HUANGLONGBING) TO THE CITRUS INDUSTRY IN SARAWAK

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ABSTRACT

The citrus industry is an important fruit industry in Sarawak, providing a livelihood to many growers and supplying mainly to the domestic market. In 1988, the citrus greening disease (CGD) or 'Huanglongbing' was first detected in Sarawak in the Samarahan Division. By 1991, the disease managed to destroy a total of 1143 ha of citrus trees in the Samarahan Division, resulting in an estimated economic loss of RM 6.5 million. This disease is also present in Indonesia, Thailand, Vietnam, the Philippines, Bangladesh, India, Papua New Guinea, Taiwan, China, Japan (Okinawa), Florida and South Africa.

The disease, which is caused by the bacterium "*Candidatus* Liberibacter asiaticus", causes dieback of the citrus trees. After the decline of the citrus industry in the Samarahan Division in the early 1990's, the Department of Agriculture produced disease-free planting material for replanting by farmers in the Samarahan Division. The disease became severe again around 2001-2002.

The use of CGD-free planting material and good field surveillance are key factors in the prevention and management of the citrus greening disease.

Citrus production is a good income generator. The citrus fruit, especially the honey mandarin, is a good import substitute for oranges and mandarins. It also has good potential as an export crop with its comparatively long shelf life and easy handling and transportation characteristics.

This paper discusses CGD, how it spreads and its effects on the citrus trees in particular, with a case study, and the citrus industry as a whole. It also highlights some important management issues that are paramount to ensuring a healthy orchard.

Key words: Citrus greening, huanglongbing, "*Candidatus* Liberibacter asiaticus"

1.0 INTRODUCTION

Citrus is an important fruit crop in Sarawak, providing a livelihood to many growers who supply mainly to the domestic market. The estimated total acreage under citrus planting in 2005 was 3,249 ha (Agricultural Statistics of Sarawak, 2005). In 2005, Sarawak exported an estimated 28.35 metric tonnes of fresh orange, and at the same time imported 5,245.38 metric tonnes of fresh, chilled or dried citrus fruits. Domestic consumption was high and the export volume was low.

Limau Manis makes up most of the production, with Limau Madu becoming increasingly more popular. Pummelo and Limau Kesturi are also grown in certain areas. Neck orange is grown only by a small number of farmers, in addition to either Limau Manis or Limau Madu. The major producing areas are in the following Divisions: Samarahan, Sarikei, Bintulu and Sibu.

In 1988, a disease known as citrus greening disease (CGD) or huanglongbing was discovered in the orchards in Samarahan Division.

2.0 CITRUS GREENING DISEASE AND ITS EFFECTS ON THE CITRUS TREE

The causal bacterium of CGD, "*Candidatus* Liberibacter asiaticus", cannot be cultured like most bacteria. It is restricted to the phloem tissues of the tree and is spread vegetatively through marcotting and bud grafting. There is no record of seed transmission. The bacterium is also transmitted by an insect vector, the Asiatic or Oriental Citrus psyllid, *Diaphorina citri.* In Africa, a different species of psyllid, *Trioza erytreae*, is the vector and the bacterium is "*Candidatus* Liberibacter africanus". The disease was first discovered in China, and was named "yellow shoot" or huanglongbing. The adult psyllid, and the fourth and fifth instar nymphs can carry the bacteria (Chen, 1998). An infected plant will start to show symptoms from four months to one or more years after feeding by infected psyllids.

An infected tree will display leaves with symptoms similar to nutrient deficiency, especially zinc and manganese deficiencies, and sometimes on only certain sectors of the tree canopy. The sectorial effect, where only certain branches show symptoms, is quite a good indicator of the presence of the disease, in psyllid transmitted infected trees. Leaves sometimes show mottling, and can remain small and become leathery and narrow, sometimes curling backwards. Dieback of the branches occurs. Branches are also more erect. In a severe infection, fruit remain small and seeds become aborted. Sometimes, the fruit also become distorted (lopsided) (Sdoodee & Garnett, 1994). Eventually the tree dies.

3.0 EFFECTS OF CITRUS GREENING DISEASE ON THE CITRUS INDUSTRY IN SARAWAK

The Samarahan Division was one of the major citrus producing areas in Sarawak in the 1980's. The detection of CGD in this Division in 1988 was the first in Sarawak. The bacteria cause dieback of the citrus trees. By 1991, the disease managed to destroy a total of 1,143 ha of citrus trees in the Samarahan Division, resulting in an estimated economic loss of RM 6.5 million (Wee, 1996). Citrus fruits had to be imported from a neighbouring country to meet local demand. This disease is also present in Indonesia, Thailand, Vietnam, the Philippines, Bangladesh, India, Papua New Guinea, Taiwan, China, Japan (Okinawa), Florida and South Africa.

After the decline of the citrus industry in the Samarahan Division, the Department of Agriculture started producing disease-free planting material in 1996 for replanting by growers there. The disease-free planting material was produced using budwood obtained through shoot-tip micro-propagation (Teo, 1996). The Department also recommended the destruction of infected orchards. However, only an estimated 40% of growers followed the recommendations. Many growers also marcotted from their existing trees, some of which were infected with the disease. As a result, the disease started to spread. It became widespread again in the Samarahan Division around 2001-2002, destroying many orchards.

In 2005, the estimated total acreage of citrus planting in Sarawak was 3,249 ha, with 2,191 ha planted with Limau Manis (Langkat etc.), 762 ha planted with Limau Madu, and 296 ha with pummelo (Agric. Statistics of Sarawak, 2005). If CGD were to wipe out all the citrus orchards in Sarawak, the losses would be great, and the cost of importation from neighbouring or other overseas countries would put a big dent in Sarawak's balance of trade. There is also added cost to the replacement of the citrus trees, and the cost of disease eradication.

A Case Study

A citrus orchard with 472 (1.43 ha based on 330 trees/ha) Limau Madu trees, belonging to a grower in Samarahan Division, was observed to have a decline in production at the end of 2004. The grower started pruning off the affected branches and roots, and treating the trees with trace elements like zinc and manganese. This was brought to the attention of the Research Branch of the Department of Agriculture in mid-2006, and sampling of the leaves was carried out. The samples were brought to the Plant Pathology Laboratory in the Research Branch at Semongok, and tested using a molecular diagnostic technique, PCR (Polymerase Chain Reaction). Fifty-five of the trees (11.7%) tested positive for CGD. This figure could have been higher as most of the diseased branches had already been pruned off by the grower at the time of sampling. In this orchard, CGD affects the tree in a sectorial manner. The

grower was advised to remove the infected trees, but he did not, as he still wanted to find a cure for them. By early 2007, the fruit production has almost stopped, and the farmer found it not economical to harvest. He carries out minimal field maintenance now.

During the good years, the grower said he could get a harvest of 150-200 kg/tree per year. He was selling the fruit directly to outlets at RM 3.00/kg and RM 3.50/kg for the smaller and the larger fruits respectively. If it is assumed that the average annual yield per tree for the 9-year old trees is 175kg, and that of the 14-year old trees is 100kg/tree, his estimated annual loss of income for 2007 and the coming years is RM 238,800 per year (Table 1). This does not take into consideration his orchard maintenance and farm input costs.

Table 1: Estimated annual loss of income by a Limau Madu grower in Samarahan Division

Age of tree as at mid-2007	No. of trees	Average annual yield per tree (kg)	Total annual yield loss (kg)	Estimated loss of income per year (RM) @ sale price of RM 3.00/kg
9 years	432	175	75,600	226,800
14 years	40	100	4,000	12,000
TOTAL	**472**		**79,600**	**RM 238,800**

4.0 DISEASE MANAGEMENT

CGD is a devastating disease that is not curable at present with the existing registered pesticides. As such, good disease management must be implemented. An integrated disease management comprising the following elements is hereby recommended.

4.1 Use of disease-free planting material

In Samarahan Division, one of the major modes of disease transmission between orchards and within orchards is the use of infected marcotted planting material. To reduce cost in the process of increasing the acreage of their citrus orchards, many of the growers either carried out their own marcotting, or purchase them from other growers. In this process, some unknowingly are introducing CGD into their orchards. Movement of infected citrus material is the most efficient way of disseminating the disease, and sometimes the psyllids. It is believed that this is how the disease came into South-East Asian countries (Aubert, 1990).

The use of disease-free planting material from reliable sources is the first and most important step towards good disease management. The source bush for disease-free planting material should be kept in well-maintained insect-proof net houses.

4.2 Constant surveillance of orchard and vector control

Due to the enormous damage this disease can cause to a high investment citrus orchard, constant surveillance of the orchard should be carried out. Surveillance should be done to check for disease symptoms on the trees as well as for the psyllid vectors. When leaf nutrient deficiency symptoms are observed, looking for tree sectorial patterns can help to give an indication on the disease status. This is especially so in cases, where the disease is introduced through feeding by infected psyllids. The disease, when introduced through marcotts, might not show the sectorial effect. For confirmation of the disease, samples of about 40 desiccated leaf midribs from leaves with symptoms can be sent to the Plant Pathology Laboratory at the Agricultural Research Centre at Semongok.

Yellow sticky traps hung on the tree can be used to monitor the psyllid vectors. The adult psyllids and their nymphs feed on the new flushed shoots and are often found on the under surface of the leaves. The psyllid can have a life span of up to 3-4 months (Chen, 1998).

Vector control should be carried out if the population is high, especially if neighbouring orchards have the disease. The psyllid population is highest when the new flushes appear, after application of fertiliser and followed by rainfall.

4.3 Removal of alternate host plants for the "*Ca.* Liberibacter asiaticus" and the psyllid vectors near citrus orchard

All known hosts for both organisms should be removed from the surrounding areas near citrus orchards, to ensure that they do not act as reservoirs for the bacteria or the psyllids. Three of the genera of the Citrinae, *viz Citrus, Poncirus* sp. (a trifoliate orange often used as a rootstock for cultivated citrus or a parent in citrus breeding programmes) and *Fortunella* sp. (kumquat) can be infected by the CGD bacteria (Aubert, 1990). There are some indications that the jasmine orange, *Murraya paniculata,* previously thought to be a non-host of the bacteria, might be able to harbour the bacteria too (Beattie, Jacobson and Holford, 2006?).

The periwinkle plant (*Vinca/Catharanthus rosea* L.) can be infected with the bacteria through transmission by the dodder plant (*Cuscuta campestris*) (Garnier & Bove, 1983). However, both plants are not known to be hosts for the psyllid.

It is observed that among the commercial citrus, there is a range of systemic reactions to the disease, from relatively mild to extremely severe (Aubert, 1990). The group of acid citrus (limes and lemons) is much less sensitive than the group

of sweet citrus (mandarins, oranges, tangors and tangelos), and *Poncirus* sp. is tolerant, but not immune. Tolerant citrus may pose a higher risk as disease inoculum reservoirs by harbouring high levels of the bacteria.

The host range for the psyllid, *D. citri*, is broader than that for CGD. The jasmine orange plant (*Murraya paniculata*) and the curry leaf plant (*Murraya / Bergera koenigii*) are major host plants for the insect vector, the psyllid. The egg production is strongly influenced by the availability of flush points for breeding sites (Aubert, 1990). In Fujian, China, the jasmine orange has been observed to produce more spring flushes than the mandarin, *Citrus reticulata.* Therefore, the Murraya plants should not be planted near the citrus orchards.

4.4 Removal of diseased trees

Infected trees should be destroyed immediately, to prevent it from becoming a reservoir for the bacteria. In some cases, growers refuse to remove the infected trees as they still want to harvest from the infected trees. Davis, Gunua, Kame, Tenakanai and Ruabete (2005) proposed that in an infected field, all surrounding citrus trees within 50m should be destroyed together with the infected tree, while in the Philippines the recommended area is 20m x 20m. Before destruction of the diseased and surrounding trees, the psyllids have to be killed first by spraying insecticide to prevent them from flying to adjacent areas (Aubert, 1990; Davis *et al.*, 2005).

Some farmers will only want to remove the infected branches. However, from field observations of citrus orchards in Sarawak and the Terengganu Citrus Valley, the new shoots appearing from the pruned branches will still be infected. Eventually, the whole tree became infected as the disease organisms spread within the tree. This practice is discouraged as the pruned tree serves as a reservoir for the bacteria which the psyllids can transmit to the other healthy trees.

4.5 Introduction of trees as windbreakers

Planting trees around citrus orchards, to act as windbreakers to prevent the aerial movement of psyllids between orchards, is encouraged. In Thailand, it was observed that CGD was more prevalent in flat fields than in those surrounded by hills or windbreakers due to the enhancement of vector dissemination by the wind (Koizumi, Prommintara, Linwattana and Kaisuwan, 1997). They observed that in hill areas with gentle slopes, the disease spread in the leeward direction. It was also observed that the psyllids can be disseminated over a distance of 500m in flat fields.

Trees like *Baphia nitida* or the Mast tree, *Polyalthia longifolia* (also known as Mempisang or Semukau), when planted closely together can serve as a tall screen to stop the psyllids from being blown into an orchard from the

neighbouring orchards. *Baphia nitida* is a leguminous tree that grows very well in Sarawak. It can reach 5m in height and is also known as camwood (Adenan, 1991) or African sandalwood. It is easily propagated through cuttings, and can reach 3m within a year. However, it needs regular pruning to maintain a slender shape to serve as an effective screen. The mast tree, which originates from South India and Sri Lanka, is fast growing once it is established, and it is propagated from seeds. It can grow up to 18m (Chai, 1984).

4.6 Intercropping with guava

On-going trials in Indonesia and Vietnam using guava as an intercrop in citrus orchards are showing indications that the presence of guava trees can reduce the psyllid field population (pers. com. Andrew Beattie). These trials are collaborative projects with ACIAR. The hypotheses are that the guava leaves are either producing insect repellents or preventing the psyllids from ovipositioning.

5.0 CONCLUDING REMARKS

CGD is a disease where concerted efforts must be made by growers, the nurseries and the government to contain the disease. It is like a social disease, where your neighbours also play an important role in ensuring that they too do not have the disease, or that they do not pass the disease to you. It is very costly for a grower to contain the disease, if his neighbours were to have infected orchards.

The government can play a role in assisting the nurseries to supply disease-free planting material, and in helping growers to diagnose the disease. The nurseries have to be reputable and act responsibly to earn the trust of their clients.

In cases, where the disease is rampant and where growers face insurmountable problems with neighbouring orchards or with the disease itself, the government might have to come up with legislative control measures. In the Okinawa Prefecture of Japan, legislative control is established to regulate the movement of citrus planting material, the disease organism and the vector (Kawano, 1998).

Citrus, especially Limau Madu, is a very lucrative crop. It has a good domestic demand, is a potential good export earner and import substitute for the imported fresh or dried citrus fruits. The fruits keep and travel well. Being a perennial crop, the labour demand is relatively lower after the initial establishment of the trees. A well maintained orchard can provide a handsome income to the grower.

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