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IMPLEMENTATION OF GREEN AGRICULTURE TECHNOLOGY FOR REDUCING CVPD INCIDENCE

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ABSTRACT

Indonesia is the world citrus producer with more than two hundreds varieties of citrus. Most of citrus orchards have been destroyed by Citrus vein phloem degeneration (CVPD). CVPD is the most impediment disease in citrus production in the world. It mainly vectored by *Diaphorina citri* Kuwayama. Intensive application of insecticides was ineffective and also costly. Comprehensive strategy for reducing CVPD is being conducted and evaluated by the integration of planting disease free trees, and controlling disease vector (*D. citri*). The vector control consists of guava intercropping, alternative host sanitation, planting area isolation, and mineral oil application. The strategy would decrease the infection of CVPD by reducing the inoculums titer, eliminating contacts between disease inoculums with the vector, and decreasing infective vector population.

Keywords: Citrus, disease free trees, *D. citri*, guava intercropping, mineral oils

INTRUDUCTION

Indonesia is currently the second world citrus producer after China with more than 210 varieties of citrus. The citrus production in 1995 was 143,059 ton, and it decreased to 91,469 ton in 1996. The production increased into 696,422 ton in 1997 and decreased sharply into 449, 552 ton in 1999. Recently, citrus production in Indonesia has developed rapidly. In 2007, the production increased to 2,625,884 ton. In 2008, the production decreased again into 2,467,632 ton and in 2010 were 2,032,665 ton due to the orchard extension. However, the production dropped again into 1,611,924 ton in 2012 (BPS, 2013). Fluctuation on citrus production was mainly caused by Citrus vein phloem degeneration (CVPD). The disease caused 50 million citrus trees lost both in South Asia and South East Asia (Gonzales, 1987). CVPD was first reported in Indonesia in 1964 (Semangun, 1991). Severe epidemics of the disease occurred in the 1960s, especially in Java and Sumatera where at least 3 million trees were destroyed. It was informed that the disease has destroyed 9 million out of 42.8 million total citrus-trees in Indonesia in 1990, with economic loss was about 35 billion rupiah per year (Nurhadi, 1991). Many highly productive plantations where yields were 20 ton per ha decreased sharply into 8.6-15 ton per ha per annum (Irawan *et al.,* 2003). A citrus rehabilitation program based on the synthetic pesticide approach to eradicate vector and disease was initiated in the

mid 1980s. However, the citrus trees in Indonesia have not been free of CVPD (Bove *et al.,* 2006). CVPD continues to be the major impediment to citriculture in Indonesia. Currently, green agriculture approach started to be applied to reduce CVPD incident instead of synthetic pesticide. Green agriculture is agricultural practices that are involved the "green technology" in the production. It is considering of biological diversity; is keeping harmony and unity of nature and economy during the course of agricultural development; and is producing of pollution-free and nuisance-free products (Zhongdong, 2002).

A. CVPD

CVPD, also recognised as Huanglongbing or greening disease, was firstly found and produced a serious problem in the Chaozhou/Shantou region of Guangdong in the mid 1930s (Lin, 1956). The disease epidemic was found in some Asian countries (Tirtawidjaja *et al.*, 1965; Garnier & Bové, 2000; Weinert *et al.*, 2004), and in the Arabian Peninsula (Bové & Garnier, 1984). It was also found in Africa, Mauritius and Réunion (Garnier *et al.*, 1996), United States of America (Florida and Louisiana), Cuba (Martínez *et al.*, 2008), and Brazil (Teixeira *et al.*, 2005).

At the initial stage trees develop mottle leaves in one or few branches similar to that caused by the lack of zinc (Dwiastuti *et al.*, 2003). Leaves become smaller and bunchy. The fruits become bitter and sour and the sugar concentration decreases. CVPD agent is a fastidious or unculturable Gram-negative bacterium with the proposed name '*Liberibacter asiaticus*' and '*Liberibacter africanus*' for Asian and African types, respectively (Nakashima *et al.*, 1998). The latent period in citrus plants before symptoms is expressed ranges from four months to one year or more. Once the citrus plant has been infected, it will die in two to four years (Su & Huang, 1990).

CVPD is not transmitted by seeds, but is naturally transmitted through vegetative propagation and by insect vector (Subandiyah *et al.*, 2000). '*Candidatus L. africanus*' is transmitted by insect vector of *Tryoza erytreae* while '*Candidatus L. asiaticus*' and '*Candidatus L. americanus*' are transmitted by *D. citri* (Bove, 2006). Only adult psyllids and the 4-5th instar nymphs are able to acquire the pathogen (Capoor *et al.*, 1974; Xu *et al.*, 1988). Once the psyllid vector acquires the pathogens, it can transmit them throughout its life span. However, it cannot transfer the virulence to its progeny via eggs (Xu *et al.*, 1991; Hung *et al.*, 2004).

B. Control Strategy

The impact of citrus production intensification has led to heavy use of pesticides for reducing pest populations, and spread of the pest-carrying pathogens. Most emphasis has been placed on contact and systemic synthetic insecticides to kill insect pest eggs, nymphs or adults, but use of these and other chemicals merely slow inevitable death of trees from the pest and disease attack. The negative side-effects relating to the use of synthetic chemicals include the destruction of predators and parasitoids, rapid development of resistance to insecticides, resurgences in pest densities, and risks to farm workers and environmental quality (Westigard *et al.*, 1986). The systemic insecticide, imidacloprid, is effectively controlled the pest, however the whole part of plant will contaminated by its active ingredient (Mendel *et al.*, 2000). Infected adult

psyllids can also transmit the pathogen while acquiring lethal doses of insecticide (Beattie & Barkley, 2009). Very limited emphasis has been placed on strategies to reduce feeding, oviposition and ingress of psyllids into orchards by altering the behaviour of adults. Integrated strategy for controlling CVPD can be developed by using disease free trees, mineral oil application, guava intercropping, alternative host sanitation, and planting area isolation. It also contributed in reducing highly poisoned pesticides contamination in ecosystem, especially in the area of citrus orchards.

1. Disease free trees

Citrus plants that are free from CVPD are the main materials for combating CVPD infection in new citrus orchard. The main source of grafting materials of Indonesian citrus is at Tlekung. Varieties are cleaned-up using standard Shoot Tip Grafting (STG) techniques and regrafted to produce Foundation Blocks (FB) as the primary sources of budwood. Confirmation of CVPD infection is regularly conducted. The system for the distribution of virus-free budwood and stocks for FBs to the grower is so long that risks of reinfection cannot be avoided. Phytosanitary quality in the citrus nursery is the crucial and critical part in supplying CVPD free trees (Supriyanto & Whittle, 1991). The citrus orchard will be kept free from CVPD infection by the lack of its inoculums. Characteristic symptom of CVPD infection was found 29 months after planting of CVPD free trees. It was due to the infestation of its vector nine months before (Poerwanto, 2010).

2. Planting area isolation

It had been reported that plant odours (volatile) vary substantially, depending on species, cultivar, growing conditions, age and plant parts (Takabayashi *et al.,* 1994), and it plays an important role in host plant selection by herbivorous insects (Bichao *et al.,* 2005). Establishing new citrus orchard in the isolated area will delay the *D. citri* infestation and CVPD infection. It takes longer time for citrus plant odours to be detected by *D. citri* and attract its colony to infest. Initial colony of *D. citri* was found 20 months after planting at new citrus orchard in an isolated area, far from the established citrus orchard and was surrounded by paddy's field. Five months more was needed for the colony of *D. citri* to colonized 100% citrus plants in one block. The colonization of *D.citri* in other blocks started from one plant spread to other plants at the same block before migrating to other nearby blocks (Poerwanto, 2010). The spread is very slow because the flight ability of psyllid is limited to 0.5-2 km when searching for a host; dispersal over 90 km is, or may be, possible in strong winds, such as those associated with cyclones (Halbert *et al*., 2008).

3. Alternative host sanitation

The hosts of CVPD agent are not only citrus, but also *Catharanthus roseus* (periwinkle), *Cuscuta campestris* and ornamental plants, such as orange jasmine (*Murraya exotica, Murraya paniculata*) also. *D. citri* colonies are also found on *Murraya paniculata*, *Murraya exotica*, and *Bergera koenegii* all year round (Tsai *et al*., 2002). Four of 16 species of weeds in citrus orchards are able to be the alternative host.

There are *Alternathera philoeroides*, *Amaranthus spinosus*, *Ludwigia perrenis*, and *Boerhavia erecta* (Hardiastuti & Poerwanto, 2011).

D, citri was able to survive a maximum of eight days with the mean longevity of 5.91 ± 0.251 days on the broadleaf weed *B. erecta*, but was not able to complete one life cycle. The ability to survive in non host plants indicated the existence of nutrients content in the weed that resembles its host plant nutrient content or the existence of certain substances that could stimulate *D. citri* to stay for feeding (Hardiastuti & Poerwanto, 2011). The substances could be a various compounds of alcohol and aldehyde from the leaves of which were specific and volatile used by insect to find its host plant (Visser, 1986). However, the type and number of nutrient content was not as complete as in the host plant for surviving and completing its life cycle. Similar results were also obtained by Sudiono and Purnomo (2008) in Gemini virus isect vectors (*Bemecia tabaci*), and Hardiastono (2001) on Peanut Stripe Virus (PStV). *B. tabaci* were able to live on broadleaf weed *Ageratum conyzoides*. The weeds also serve as a source of inoculum since they were able to be infected by Gemini virus.

The implications of those survivorships of *D. citri* in ornamental plants and some weed species is the presence of alternative host for *D. citri* when citrus plant is not available as a food source, either because there are no plants or when plants are treated with pesticides. The existence of alternative host will cause the population of D. citri is available throughout the season and serve as initial population for the next generation population. The role of *D. citri* as a propagative vector of CVPD pathogen will also make the disease inoculums always available throughout the season in field (Hardiastuti and Poerwanto, 2011). Alternative host sanitation could be an effective control measures against CVPD on citrus plant, since the disease transmission is highly dependent on the availability of disease inoculums and insect vector population in the field.

4. Guava intercropping

Based on observations by Vietnamese ACIAR researcher team, it is suggested that citrus groves intercropped with guava trees was free from *D. citri* invasion and low incidence of CVPD-infected trees (Beattie *et al*., 2006). Certain volatile compounds in guava leaf could be developed as repellents for citrus psylla. Guava fruits and leaves produce a wide range of volatile compounds, such as sesquiterpenes (Sagrero-Nieves *et al*., 1994; Ogunwande *et al*., 2003), aldehydes and alcohols (Idstein & Schreier, 1985; Begum *et al*., 2004; Soares *et al*., 2007). Some of these aldehydes and alcohols are the so called 'green leaf volatiles' that have been shown to have repellent effects on insects (Jang & Light, 1991).

The present study revealed that the repellent action of guava against citrus psylla is dose-dependent, with very low doses having little effect on citrus psylla. This result indicates that to control citrus CVPD by intercropped guava trees in citrus groves, sufficient numbers of guava trees are needed to keep the dosage of volatile compounds emitted from guava at an effective level in the entire grove (Zaka, *et al*. 2010). In China, observations revealed that even in the presence of guava trees scattered inside or around the groves, citrus psylla populations are high. This could be due to the fact that the guava trees present did not release enough active volatile compounds (Beattie *et al*., 2006). Intercropping guava among the young citrus plants with ratio of guava: citrus

population is 1:8, resulted no *D. citri* population and CVPD symptom found in the orchard, whilst CVPD symptoms (was confirmed with PCR) and 0.4 imago of *D. citri* with 0.3 nymph colony and 0.1 egg colony per plant were found in the orchard 100-1000 meters apart away planted of 50-200 citrus trees of 3-6 years old (Pustika *et al.* 2008). In Vietnam, it was suggested that guava trees are intercropped prior to citrus at a ratio of one guava tree to one citrus tree (Beattie *et al.*, 2006).

5. Oils application

Taverner (2002) has reviewed the toxic effects of mineral oils and listed several routes of potential mortality with mineral oils usage in addition to smothering effects. They included: fumigant action, narcosis, nervous disruption, corrosion of insect tissues, cell disruption, and desiccation. Two recurring themes are evident in the literature regarding the use of petroleum-derived spray oils in integrated pest and disease management programs. First, a mineral oil is non-selective but has short residual activity. Those mineral oils are less phytotoxic to the plant and do not induce any carcinogenic effect to human (Beattie, 2010; personal communication). Second, a mineral oil gives minimal disruption of beneficials (Childers, 2002). A third, and very important benefit of using mineral oils, is that no arthropod resistance development is known with the use of petroleum oil spray applications.

Mineral oils are highly refined mineral oils derived from crude petroleum oils. They are paraffinic (≥ 60% of carbon atoms occur in chains). Horticultural Mineral Oils (HMOs) are called narrow-range petroleum spray oils and Agricultural Mineral Oils (AMOs) are called broad-range petroleum spray oils. Common median *n*Cy values of HMOs are *n*C21 and *n*C23. For AMOs they are *n*C23, *n*C24 and *n*C25 (Agnello, 2002; Beattie, 2009).

Oils have behavioural effects on insect pest. The use of oils was effectively reduced pest population as oviposition and feeding deterrence. The oil film could provide a barrier by physical disruption of epicuticular lipids and masking of feeding and oviposition stimulants preventing the insect from locating, accepting or using the host plant. Application of mineral oils could also increase the release of volatiles which were used as olfactory cues. The volatiles were naturally released in response to feeding by herbivorous insect (Xue *et al.*, 2009).

Application of oils for citrus pests is ranged from 0.4% to 0.5% sprays at 5-14 day intervals within flush cycles (Poerwanto *et al.*, 2008, 2010). They reduced 56.7% - 61.3% proportions of psyllids attracted to citrus (Poerwanto *et al.*, 2008). *D. citri* gravid female rejected to lay their eggs on citrus treated with mineral oils (Rae *et al.*, 1997). Responses of adult *D. citri* to mineral oil deposits are olfactory and related to detection by antennal receptors of oil volatiles and/or plant volatiles (Poerwanto *et al.*, 2012). This outcome indicates that application of the oils to the mandarin leaves may have: (a) suppressed release of attractant host plant volatiles; (b) masked attractant host plant volatiles; (c) led to the release of repellent volatiles from leaves; and/or (d) to adults being repelled by oil volatiles (Poerwanto *et al.*, 2008; 2012). Oils application also attract parasitoid (Poerwanto & Brotodjojo, 2011) and predator insect (Poerwanto, 2010) giving multiple control measure to *D. citri*.

CONCLUSION

CVPD incidence reduction should be comprehensively conducted by implementing green agriculture technology instead of synthetic pesticide. It should be started by seeking new area for establishing citrus orchard. The area should be far enough from citrus orchard and free from alternative hosts of CVPD and its vector. Second step is interplanting guava among citrus plants followed by using mineral oils when the vector colony was found. Last but not least is keeping the orchard always clean of weeds which could be used as alternative host by vector.

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