Diseases and pests of citrus in Viet Nam

A.M. WHITTLE

Key words: Citrus diseases, citrus pests, citrus, Viet Nam

Summary. In Viet Nam the total area under citrus cultivation is currently about 5 000 ha, but plans are to increase it to some 40 000 ha by the year 2000 for a total projected annual production of 450 000 t. Two surveys were carried out in August 1990 and March 1991 to identify and list the pathogens and diseases affecting citrus production in Viet Nam, which include greening, a serious problem in Southeast Asia, and citrus canker, tristeza virus and exocortis. Citrus pests, including Diaphorina citri – the vector of greening – and many others, were also identified and are described in this article.

Viet Nam stretches a distance from north to south of over 1 609 km and has a widely varying climate (see map). The far north is a mountainous area where the climate is almost temperate, while around Hanoi the annual temperature range is wide, with very high summer temperatures and winter minima as low as 6°C. The northern region is subject to monsoons and typhoons, whereas in the south the temperature fluctuates much less, there being a tropical climate not unlike that in the Philippines.

Since Viet Nam is so close to the centre of origin of many Citrus species, it is assumed that the cultivation of citrus there is ancient. It seems to have been little affected by external influences; in fact, most of the cultivation in the north is based on a small number of local orange varieties, primarily Song Con, Van Du and Xa Doai. Non-native varieties such as Olinda, Valencia Late and Washington

MALADIES ET RAVAGEURS DES AGRUMES
AU VIET NAM

Résumé. Au Viet Nam, la superficie totale des vergers d’agrumes est actuellement de 5 000 ha, mais il est prévu de la porter à quelque 40 000 ha d’ici l’an 2000 pour atteindre une production annuelle de 450 000 tonnes. Deux études ont été réalisées en août 1990 et mars 1991 pour identifier et recenser les pathogènes et les maladies des vergers d’agrumes au Viet Nam et notamment la virescence – qui pose un grave problème en Asie du Sud-Est – ainsi que le chancro des agrumes, la tristeza et l’exocortis. Les ravageurs des agrumes, notamment Diaphorina citri, vecteur de la virescence, et beaucoup d’autres sont également décrits dans l’article.

ENFERMEDADES Y PLAGAS DE LOS CÍTRICOS
EN VIET NAM

Resumen. En Viet Nam, la superficie total dedicada en la actualidad al cultivo de los cítricos es de unas 5 000 hectáreas, pero se prevé aumentarla hasta alrededor de 40 000 hectáreas para el año 2000, con una producción anual total prevista de 450 000 toneladas. En agosto de 1990 y en marzo de 1991 se realizaron dos estudios para identificar y catalogar los patógenos y enfermedades que afectan a la producción de cítricos en Viet Nam, entre ellos el verde - problema grave en Asia sudoriental – y el cáncer de los cítricos, el virus de la tristeza y el exocortis. Plagas de los cítricos como Diaphorina citri, vector del verdeo, y otras muchas han sido identificadas también en este país, y se describen en el presente artículo.

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Navel, introduced as recently as the late 1970s, have not achieved much popularity. By far the most popular rootstock is pummelo, Citrus maxima (Burm.) Merr., although some orchards have been established on Cleopatra mandarin and a probable sour orange hybrid. Some pummelos are also grown in the north, but most other species or varieties exist mainly in collections and have not been commercially evaluated.

In northern Viet Nam citrus is grown mostly on 15 state farms which are generally fairly isolated. Individual plantings are no more than a few tens of hectares. Citrus cultivation in southern Viet Nam is primarily based in Bien Hoa Province (pummelos) and Cuu Long Province in the Mekong Delta. In Cuu Long, citrus is grown on small farms and is based on a marcotted mandarin type, Duong (meaning “sweet”), which is identical to the very popular Citrus sahuimensis Hort. ex Tanaka known elsewhere as Som Khe Wan (Thailand), Limau Langkat (Malaysia) and Keprok Siem (Indonesia). This species, almost always propagated by marcots, forms the basis of citrus production in swampy areas throughout the region.

The total area under citrus cultivation in the country is currently about 5,000 ha, but plans are to increase this to some 40,000 ha by the year 2000, by which time the total annual production is expected to reach 450,000 t. Large-scale citrus production is now in its third cycle of planting, earlier orchards having reportedly been destroyed by greening disease.

This report is based on observations made during two surveys made by the author in August 1990 and March 1991 to identify important citrus diseases and pests in Viet Nam.

**GREENING DISEASE AND DIAPHORINA CITRI**

Greening disease, associated with a gram-negative bacterium, is widespread throughout South and Southeast Asia. In most all of these areas it is the most serious disease of citrus; in Indonesia, for example, it has caused the loss of many millions of trees. In general the disease is spread to new areas by infected budwood or nursery plants, and within orchards by the Asian citrus psyllid Diaphorina citri Kuwayama (Capoor, Rao and Viswanath, 1967). In most parts of Southeast Asia, citrus is grown by small farmers with plantings of often less than 100 trees. Until recently there has been little understanding of the factors influencing the disease, and extension work aimed at greening control has been generally ineffective. Small farmers are frequently reluctant to practice sanitation, preferring to retain declining trees until they practically cease bearing. This practice tends to increase vector populations, as D. citri breeds exclusively on young flush (Capoor, Rao and Viswanath, 1967) and one symptom of greening is unseasonal flushing (Lin and Lin, 1990).

In northern Viet Nam, where citrus is mostly grown in larger orchards on state farms, the recent history of citrus cultivation has been essentially cyclical, with the gradual destruction of orchards by greening followed by wholesale removal and replanting. Some attempts have been made to select greening-free planting material, but without the rigorous management that this requires; hence greening occurs in some nurseries, albeit at low frequency. A new cycle of planting was started about five years ago, and greening is already evident. The frequency of infection of neighbouring infected plants is high and the disease has spread rapidly in most orchards.

Calculations by Mr. R. Rath (Van der Plan) showed that greening could be significantly reduced by the use of large vectors parasitoids and other effective control measures in a cost-effective manner. The removal of infected plants and adequate sanitation have to be effective to control the disease cost-effectively. In the period only.

While production in northern Viet Nam during the rainy season at Ho Chi Minh City be completely eliminated, a bush of M. sinensis to control the disease. It must be remembered that this is a very serious and destructive disease.
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about five years ago and greening infection is
already evident in many of these young orchards.
The frequency is still low, with clearly defined foci
of infection affecting only immediately
budding trees. Only at a few sites were vector-
transmitted infections apparent several rows dis-
tant from the primary infection sources. Such a
disease distribution is to be expected from a slow
rate of spread, a characteristic supported by the
comparatively low populations of D. citri observed
in most orchards.

Calculations based on data from Java, Indonesia
(MR R. Rathgeber, personal communication), using
Van der Plank's equations (Van der Plank, 1963),
showed that the rate of spread of greening was not
significantly affected until vector populations were
reduced by 60 to 70 percent. This explains why
vector parasites in Indonesia have failed to give
effective control, necessitating the use of insecti-
cides in a control programme. The significance of
these observations for Viet Nam is that vector
populations can be expected to increase steadily
unless the flushing period is restricted by early
removal of infected trees; i.e. the importance of
sanitation lies not only in the removal of infection
sources but also in the control of vector popu-
lations. In a country such as Indonesia where very
large vector populations are now the norm because
of small farmers' reluctance, over 30 to 40 years, to
remove infected trees, only coordinated efforts
covering entire citrus areas can be expected to yield
satisfactory results. A control programme would
have to involve a major reduction of vector popu-
lations by the removal of all infected trees and
effective chemical control. Insecticides are highly
cost-effective if used during a narrow flushing
period only, but if required throughout the year they
become very costly and are environmentally unde-
sirable.

While populations of D. citri were relatively low
in northern Viet Nam (indeed, none were seen at all
during the August 1990 visit), citrus areas around
Ho Chi Minh City (southern Viet Nam) seemed to
be completely free at both times of the year. Even
a bush of Murraya koenigi Spreng was free. In this
area there were no trees showing symptoms of
greening. It is very unusual to find such an area in
Southeast Asia, i.e. an area with a fairly long
history of citrus cultivation that has apparently
remained free of D. citri.

Although parasites of D. citri are unlikely to
provide effective control under the high population
conditions of Indonesia, they may have a useful
role under current conditions in Viet Nam. Records
show the presence of the cecidyl Diaphorinae
aligarhensis (Shafiee et al.) [syn. Aphidcerytus
diaphorinae (Myartzeva and Tryapitzyn, 1978)],
although this parasite was not collected by the
author in either visit. The eulophid Tamarixia
radiata (Waterston) [syn. Tetrasichus radiatus
Waterston] had not hitherto been recorded but was
frequently collected during the second visit in se-
veral orchards around Hanoi and Phu Quy in the
north. Observations in Indonesia indicate distinct
periods of parasite activity by those two species,
with little overlap (Nurhadi, personal communi-
cation). T. radiata is the more active and is recovered
from nymphs developing on the main flush. None of the
samples collected in Viet Nam yielded hyperparasites of T. radiata, though a substantial
number have been recorded in neighbouring coun-
tries (Qing, 1990).

OTHER DISEASES

Published lists of citrus diseases in Viet Nam are
spare (Anon., 1964, 1985, 1986), with no details
provided of systemic degenerative diseases; pre-
sumably the record of "viruses" refers to the disease
now recognized as greening. Only recently has a
programme of indexing been started. As pummelo
is not used as a rootstock in countries with a wider
experience of citrus viruses, little information ex-
ists in the literature regarding its responses. Given
the geographical position of Viet Nam it would be
surprising if citrus tristeza virus (CTV) and tatter
leaf virus were not present. Although CTV has
been reported (Do Dinh Duc, personal communi-
cation), trees of Mexican lime in various parts of
the country showed no vein clearing, so it is certainly
not as prevalent as in other countries in the region
(Muharram and Whittle, 1989). Symptoms ob-
served in an orchard at Phu Quy suggested the
possible presence of exocortis: the pummelo root-
stock showed heavy bark scaling with a profuse
gum layer between the bark and the wood; there
was no indication of stunting.
It will be several years before the shoot-tip grafting programme now being implemented produces virus-free budwood of local varieties, and an indexing programme is necessary to support selection of budwood sources, particularly if alternative rootstocks are to be employed. Alternatives will certainly be necessary, as there is ample evidence that pummelo trees are short-lived, with productivity declining rapidly from about the twelfth year.

Citrus canker, *Xanthomonas campestris pv. citri* (Hasse) Dye, is frequently severe on sweet oranges in northern orchards, exacerbated by heavy rainfall and typhoons. Bordeaux mixture is often sprayed to control the infection, but control is generally poor as sprays are timed to limit symptom expression rather than to prevent infection (Stall et al., 1981). In southern orchards canker is of much less significance because of the preponderance of mandarin types, and it is not even widespread on pummelos.

*Phytophthora* is frequently mentioned as important in Viet Nam and is locally regarded as the destroyer of much citrus in the delta areas of southern Viet Nam. Surviving trees show no symptoms of *Phytophthora* and the decline more probably result from agronomic problems associated with fluctuating water tables and salt toxicity in swamp soils (Whittle et al., 1989).

Citrus *sahuiensis* is frequently infected with *Meliola citricola* H. Sydow and Sydow in Indonesia, and the same fungus is widespread on this host (Duong) in the Mekong Delta. It was not seen on other *Citrus* species (Whittle, 1992). The density of fungal growth on leaves can be very high and the market acceptability of fruits can be substantially reduced. This disease is unrecognized in the region and is generally confused with sooty mould. No information exists on control in orchards, though the appearance of fruit can be greatly improved by bleaching (Van der Plank, Van Wyck and Van Nickerk, 1940).

Several other minor diseases have been recorded. *Elsinoë fawcettii* Bitancourt and Jenkins is common in nurseries. Powdery mildew, *Oidium tingatinum* C.N. Carter, can look severe during the dry season, but the economic damage has not been assessed.

The full list of diseases identified in Viet Nam is given in Table 1.

### OTHER PESTS

A list of pests recorded or observed in Viet Nam is given in Table 2.

The brown citrus aphid, *Toxoptera citricidus* (Kirkaldy), is widespread, but direct damage is

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**TABLE 1. Citrus diseases in Viet Nam**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Common name of disease</th>
<th>Occurrence</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>North</td>
</tr>
<tr>
<td><em>Xanthomonas campestris pv. citri</em> (Hasse) Dye</td>
<td>Canker</td>
<td>+</td>
</tr>
<tr>
<td><em>Elsinoë fawcettii</em> Bitancourt &amp; Jenkins</td>
<td>Scab</td>
<td>+</td>
</tr>
<tr>
<td><em>Oidium tingatinum</em> C.N. Carter</td>
<td>Powdery mildew</td>
<td>+</td>
</tr>
<tr>
<td><em>Phytophthora citrophthora</em> (H.L. Sm. &amp; E.H. Sm.) Leonian</td>
<td>Gummosis and foot rot</td>
<td>+</td>
</tr>
<tr>
<td><em>Capparodium citri</em> Berk. &amp; Deam.</td>
<td>Sooty mould</td>
<td>+</td>
</tr>
<tr>
<td><em>Melia citri</em> H. Sydow &amp; Sydow</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td><em>Mycosphaerella citri</em> Whiteside</td>
<td>Greasy spot</td>
<td>+</td>
</tr>
<tr>
<td><em>Colletotrichum gloeosporioides</em> (Penz.) Sacc.</td>
<td>Anthracnose</td>
<td>+</td>
</tr>
<tr>
<td><em>Alternaria citri</em> Ellis &amp; Pierce</td>
<td>Black rot</td>
<td>+</td>
</tr>
<tr>
<td><em>Penicillium italicum</em> Wehmer</td>
<td>Blue mould</td>
<td>+</td>
</tr>
<tr>
<td><em>Penicillium digitatum</em> Sacc.</td>
<td>Green mould</td>
<td>+</td>
</tr>
<tr>
<td><em>Septobasidium bogoriense</em> Pat.</td>
<td>Felt</td>
<td>+</td>
</tr>
<tr>
<td>Gram-negative bacteria</td>
<td>Greening</td>
<td>+</td>
</tr>
<tr>
<td><em>Citrus trifolera virus</em></td>
<td>Stem pitting and seedling yellows</td>
<td></td>
</tr>
<tr>
<td><em>Citrus psorosis virus</em></td>
<td>Psoriasis-A</td>
<td>+</td>
</tr>
<tr>
<td><em>Citrus exocortis viroid</em></td>
<td>Exocortis</td>
<td>+</td>
</tr>
</tbody>
</table>

**Sources:** Anon., 1964; Anon. date unknown; Do Dieu Duc. Vegetexco, Viet Nam, personal communication; A.M. Whittle, personal observations.

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1 Ed. note: See full report on this pathogen by A.M. Whittle published under “Outbreaks and New Records” in this issue of the *Bulletin.*
### TABLE 2. Arthropod pests of citrus in Viet Nam

<table>
<thead>
<tr>
<th>Taxonomic group</th>
<th>Species</th>
<th>Common name</th>
<th>Occurrence</th>
<th>Taxonomic group</th>
<th>Species</th>
<th>Common name</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARACHNIDA</strong></td>
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<td><strong>ARACHNIDA</strong></td>
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<tr>
<td><strong>Acari</strong></td>
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<td><strong>Acari</strong></td>
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<tr>
<td>Tetanychidae</td>
<td>Panonychus citri (McGregor)</td>
<td>Red spider mite</td>
<td>+</td>
<td>Coccidae</td>
<td>Ceroplastes rubens Maskell</td>
<td>Red wax scale</td>
<td>+</td>
</tr>
<tr>
<td><strong>Eriophyidae</strong></td>
<td>Phyllocophrta olivieri (Ashmead)</td>
<td>Rust mite</td>
<td>+</td>
<td>Pseudococcidae</td>
<td>Pseudococcus longispinus (Tanig.-Tozai)</td>
<td>Long-tailed mealybug</td>
<td>+</td>
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<tr>
<td><strong>INSECTA</strong></td>
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<td><strong>INSECTA</strong></td>
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<tr>
<td>Heteroptera</td>
<td>Rhynchocoris humeralis (Thunberg)</td>
<td>Green stink bug</td>
<td>+</td>
<td>Planococcus citri (Risso)</td>
<td>Citrus mealybug</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Homoptera</strong></td>
<td>Lawana candida F.</td>
<td>Citrus “white moth”</td>
<td>+</td>
<td>Margarididae</td>
<td>Icerya purchasi Maskell</td>
<td>Cottony cushion scale</td>
<td>+</td>
</tr>
<tr>
<td><strong>Hemiptera</strong></td>
<td>Aleyrodidae</td>
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<tr>
<td>Aleyrodidae</td>
<td>Aleurocanthus woglumi Ashby</td>
<td>Citrus black fly</td>
<td>+</td>
<td>Anoplocnema chinensis (Forst.)</td>
<td>Citrus longhorn beetle</td>
<td>+</td>
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<tr>
<td>Diaspidae</td>
<td>Diaspididae</td>
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<td></td>
<td><strong>Circuliferidae</strong></td>
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<td>Psyllidae</td>
<td>Psyllidae</td>
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<td></td>
<td><strong>Chrysomelidae</strong></td>
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<td>Aphididae</td>
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<td><strong>Lepidoptera</strong></td>
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<td><strong>Coleoptera</strong></td>
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<td><strong>Hemiptera</strong></td>
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<tr>
<td>Phyllonocidae</td>
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<td></td>
<td><strong>Hemiptera</strong></td>
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<tr>
<td>Phyllonocidae</td>
<td>Phyllonocidae citrella Steinhart</td>
<td>Citrus leaf miner</td>
<td>+</td>
<td>Pyralidae</td>
<td>Citripetis sagittifera Moore</td>
<td>Citrus moth borer</td>
<td>+</td>
</tr>
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<td><strong>Pyralidae</strong></td>
<td>Citripetis sagittifera Moore</td>
<td>Citrus moth borer</td>
<td>+</td>
<td>Yponomeutidae</td>
<td>Prays citri (Milliere)</td>
<td>Citrus flower moth</td>
<td>+</td>
</tr>
<tr>
<td><strong>Lymantridae</strong></td>
<td>Orgyia sp.</td>
<td>Tussock moth</td>
<td>+</td>
<td><strong>Noctuidae</strong></td>
<td>Eudicosa (syn. Ortheca) sp.</td>
<td>Fruit piercing moth</td>
<td>+</td>
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<tr>
<td><strong>Cocidae</strong></td>
<td></td>
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<td></td>
<td><strong>Tortricidae</strong></td>
<td>Hemonia coffeae (Nietn.)</td>
<td>+</td>
<td></td>
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<tr>
<td><strong>Coccidae</strong></td>
<td>Coccus pseudomagnoliarum (Kuw.)</td>
<td>Citricola scale</td>
<td>+</td>
<td><strong>Papilionidae</strong></td>
<td>Papilio demoleus L.</td>
<td>Leman butterfly</td>
<td>+</td>
</tr>
<tr>
<td><strong>Diptera</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Papilionidae</strong></td>
<td>Papilio xuthus L.</td>
<td>Swallow-tail butterfly</td>
<td>+</td>
</tr>
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**Sources:** Anon., 1964; Anon., date unknown; Do Dinh Duc, Vegeteco, Viet Nam, personal communication; A.M. Whittle, personal observations.

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limited; the pest's main importance lies in its potential as an efficient vector of the tristeza virus. The citrus leaf miner, *Phyllocnistis citrella* Stainton, was seen in most orchards and nurseries; in the latter it appears to cause extensive leaf drop, stunting and excessive side-branch formation, resulting in a generally poor quality of rootstock material. A case was seen near Hanoi where heavy insecticide use had eliminated this pest from a nursery, so it is clearly possible to obtain plants of superior quality.

In orchards leaf miner infestation frequently looks severe, and this pest is the main target for insecticide sprays, most usually methyl parathion. While infestation is often severe on the current season's growth, there seems to be little long-lasting effect, with trees retaining dense foliage. Additionally, mining on oranges is primarily on the lower leaf surface, so its effect on photosynthetic efficiency is probably less than the appearance of shoots might suggest. Parasites such as *Ageniaspis* spp. were not seen but, if not naturally occurring, could be imported. Most of the insecticides currently used for leaf miner control in Viet Nam are incompatible with an integrated pest management programme.

In general, the pest fauna in the north closely resembles that of China, whereas that in the south is closer to that more widely observed elsewhere in Southeast Asia. An example is the citrus moth borer, *Cntriopis sagittiferella* Moore, which was not encountered in the north but was frequently seen in the south on pummellos. On the other hand, many orchards in the north, particularly those established near old forest sites, are frequently heavily damaged by longhorn beetles, in particular *Nadeuhaliella cantori* Hope. The larvae of this beetle can tunnel beneath the bark of the trunk for up to three years, causing severe decline or even death of the tree.

In the north, ripening fruit is often attacked by fruit flies, primarily *Bactrocera dorsalis* Hendel (syn. *Dasoccus dorsalis* Hendel) but probably others as well. Fruit-piercing moths of the genus *Euplocmia* (syn. *Othreis*) are most commonly seen in northern orchards close to forest or uncultivated land. Apparently no estimates of damage by fruit pests have been made.

As mentioned above, the control of insect pests on *Citrus* spp. in Viet Nam currently depends on the sporadic use of sprays such as methyl parathion. The most serious pest is undoubtedly *D. citri*, yet growers do not normally regard it as a target. The pest most often cited as the justification for spraying is the leaf miner, but the economic return from such action is far from clear. Sprays that are not targeted at leaf miners are usually applied later than is necessary to control psyllids, as they also appear to contribute to very high populations of red spider mites (*Panonychus citri* McGregor).

The now largely abandoned techniques of manual destruction of borers could usefully be reinstated, as standard insecticide sprays have little or no effect. The damage done by longhorn beetles could be greatly reduced by regular insertion of wire into their clearly visible tunnels. Populations of shoot borers can be controlled by the removal of withering shoots during the winter months when larvae are still developing.

Parasites of *D. citri* are already present, and their range and numbers could well be augmented by mass-rearing. There is a clear need for further study of the entire ecosystem of citrus pests in Viet Nam with a view to a more detailed understanding of the natural enemy complex and to the identification of possible needs for introductions.

In the backyard citrus cultivation in the Mekong Delta most trees are practically free of foliar pests, largely because red tree ants, *Oecophylla smaragdina* (F.), have been deliberately encouraged in the manner implemented in ancient China (described by DeBach, 1974). In Viet Nam, chicken entails have been used as the bait to entice the ants from the trees at picking time.
sprays such as methyl parathion. One pest is undoubtedly *D. citri*, yet normally regard it as a target. The cited as the justification for sprayner, but the economic return from r from clear. Sprays that are not iners are usually applied later than control psyllids, as they also appear very high populations of red spider as *citri* (McGregor).

An ably abandoned techniques of on of burners could usefully be used. Insecticide sprays have little damage done by longhorn beetles. Reduced by regular insertion of early visible tunnels. Populations n be controlled by the removal of dying the winter months when developing. *citri* are already present, and their are could well be augmented by here is a clear need for further study system of citrus pests in Viet Nam to date detailed understanding of the complex and to the identification of r introductions.

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REFERENCES


