

CITRUS INSECT CONTROL IN TAIWAN AND A NEW INTEGRATED CONTROL METHOD¹

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ABSTRACT

Four serious insect pests of citrus of Mainland China so far do not spread onto this Island. The Yanone scale was eradicated soon after its first discovery in Taiwan in 1935. Modern insecticides have been extensively and frequently used in citrus groves during last 15 years and most insect pests are now well under control. The citrus red mite which was formerly of no importance is however becoming more and more serious and most acaricides proved to be of little help against it. When applied on the trunk at the first sign of leaf burst and a 7-10 day interval of flushing, azodrin may control most species of aphids, mealy bugs, soft scales, armoured scales and stink bugs, as well as the leaf miner, psylla, cottony cushion scale and rust mite. No apparent side effects were noted during the 5 years' operation in an experimental grove containing 1,000 citrus trees, meanwhile the activities of two predatory beetles in that grove appeared to be fairly effective in controlling the citrus red mite.

I. INTRODUCTION

The citrus insect-fauna of Taiwan resembles closely that of the southern parts of Mainland China (Kwangtung, Kwangsi, Fukien, Hunan, Kweichow, Szechuan and Chekiang Provinces), but differs markedly from the latter in the absence of the following four major pests:

- (1) Citrus leaf beetle, *Clitea metallica* Chen (Chrysomelidae). Very common in Kwangtung, Fukien, Szechuan and Hunan; also occurring Vietnam, Hainan I. and the Ryukyu Is.
- (2) Citrus leaf miner, *Podagricomela nigricollis* Chen (Chrysomelidae). Found in Kwangtung, Chekiang and Hunan.
- (3) Citrus leaf miner, *Throscorysa citri* Maulik (Chrysomelidae). Found in Kwangtung, Kwangsi and Fukien; also occurring in India.
- (4) Citrus fruit fly, *Tetradacus tsuneonis* Miyake (Trypetidae). Confined to various kinds of citrus fruits; found in Szechuan and Kweichow, and also Japan.

On the other hand, effective plant quarantine measures have probably prevented the spreading of the green scale (*Coccus viridis* Green) and root mealy bug (*Pseudococcus chaponensis* Takahashi) from this Island to Mainland China.

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II. CITRUS PEST CONTROL : 1895-1946

During the Japanese occupation of Taiwan in 1895-1946, the controlling of citrus insect pests was carried out in several directions including the handpicking of the stink bug, *Rhynchosoris humeralis* Thunberg etc. The most notable achievements in the period are the following :

(1) Biological Control : The Australian ladybird beetle, *Rodolia cardinalis* Mulsant was introduced in 1909 to control the cottony cushion scale, *Icerya purchasi* Maskell. A few years after the 53 releases of 22,727 beetles in various parts of the Island, the spraying with resin soda wash became unnecessary. At present, the indigenous beetle, *Rodolia pumilio* Weise appears to be more effective than the Australian one in keeping down the populations of that scale. Another ladybird beetle, *Cryptolaemus montrouzieri* Mulsant was introduced at about the same time to control *Nipaecoccus filamentosus* Cockerell and other mealy bugs. The results were not always satisfactory.

(2) Chemical Control : An effective resin soda wash was formulated and applied against honeydew producing insects such as the green scale and mealy bugs. The lime sulphur mixture was found to be effective against the rust mite, *Phyllocoptruta oleivora* Ashmead whereas the extract of the tobacco wastes proved to be fairly satisfactory in controlling the leaf miner, *Phyllocnistis citrella* Stainton in nurseries. In fact, the lime sulphur mixture is still in use nowadays.

(3) Eradication : The Yanone scale, *Unaspis yanonensis* Kuwana, which is a serious pest in Mainland China and Japan, was accidentally introduced and was first discovered in 1935. It was successfully eradicated by strict enforcements of destroying infested trees and other domestic plant quarantine measures.

III. CITRUS PEST CONTROL : 1946 to present

During the 8 year Sino-Japanese war and the 2nd world war, there was a severe shortage of fertilizer, pesticides and labour in Taiwan and most citrus groves were lost due to general negligence and to the combined attack of the longicorn beetle, scale insects and persistent sooty mould. In that period, the pest control depended entirely on the use of resin soda wash and lime sulphur mixture. Later, to make matters worse, the supply of resin from Mainland China for the manufacture of the wash was stopped by the Communist regime.

Resin soda wash was then replaced by a standard oil spray for citrus produced by the China Petroleum Corporation in Taiwan. Meanwhile, malathion was introduced and tested in Taiwan. It had the combined advantages of resin soda wash, summer oil and tobacco extract, but was not effective against the armoured scales.

Our Institute found that the brushing of dieldrin onto the tree trunk near the ground during the oviposition season of the longicorn beetle *Anoplophora maculata* (Thomson) was effective in controlling that pest. By this method a single grower was able to manage 1,000 trees or more. Up to the present no harmful side-effects have been noted. This method was also adopted against the same borer in protecting the tree *Casuarina*

equisetifolia which is extensively planted as wind breaks along the West Coast of Taiwan.

Dr. C. Y. Lee of our Institute was the first in Taiwan to introduce the sex attractant methyl eugenol with DDVP to control the male Oriental fruit fly, *Dacus dorsalis* Hendel, and Dr. T. W. Liew of the Joint Commission on Rural Reconstruction (JCRR) introduced the use of protein hydrolysate with malathion wettable powder as a bait spray. In addition, Dr. H. Y. Lieu of JCRR perfected a method for dipping citrus fruits in EDB solution to control, for export purpose, the fruit fly in mandarins.

Lime sulphur mixture is still a cheap and effective acaricide against the citrus rust mite but is phytotoxic under summer conditions and is incompatible with many modern insecticides. Zineb and maneb are also effective but safer, and have a longer residual effect but do not produced an attractive peel as is in the case with lime sulphur mixture.

The citrus red mite *Panonychus citri* (Mc Gregor) has developed resistance to malathion, dimethoate, chlorobenzilate and tedion, while formothion, dimecron, metasystox and ekatin are clearly becoming less effective than they were in the past. Even though chlorinated hydrocarbon insecticides are not permitted to use on citrus, dieldrin is used cautiously as a bark treatment against longicorn beetle and malathion is used solely in fruit fly baiting. The red mite continues as serious pest. In entirely unsprayed groves and those treated resin soda wash and lime sulphur mixture, the mite was not a pest and was probably kept in check by the following natural enemies: *Stethorus* sp (Coccinellidae), *Oligota* sp (Staphylinidae), *Chrysopa boninensis* Okamoto (Chrysopidae), *Scolothrips sexmaculatus* Pergande and *Leptothrips* sp. (Thripidae), *Anystis* sp. (Anystidae), *Phytoseiulus taoui* Lo and *Phytoseius coheni* Swirski et Schechter (Phytoseiidae); the first two beetle species are especially active. It is believed that insecticides applied against other pests have disturbed this predator complex and lead to repeated outbreaks of the red mite.

At present more than 39 different insecticides are recommended in Taiwan to be used on citrus for the control of 9 groups of insects, viz. leaf miner, aphids, psylla, white flies, soft scales, armoured scales, mealy bugs, stink bugs and longicorn beetle.

IV. INTEGRATED CONTROL OF CITRUS PESTS

A new method was developed in 1969 by Tao & Wu for the integrated control of the pest complex in Taiwan. In this method, trunk applications of 10% azodrin, the only systemic material found to be non-phytotoxic, are made during two of the three annual flushing periods of citrus. The base of main branches are each treated with a band of this insecticide with a width 3-4 times the diameter of the branches. The treatment is made twice at a 7-10 day interval. In Taiwan the first flush occurs in March when aphids are the main pest on the young foliage. Within the grove, the planting of rape (*Brassica campestris*) which blooms either slightly before or simultaneously with citrus, apparently encourages the buildup of aphid predators in the grove. The first double application of azodrin is made at the time of the second flush in May-June, starting with the first sign of new growth. This treatment is repeated on the third flushing period in August-September, thus giving a total of four azodrin treatment per year. Younger tree having more flush

cycles may require up to seven azodrin applications. Apart from a stem treatment of dieldrin for the longicorn beetle, no other insecticides and no fungicides were applied in this study grove.

This method was applied to 1,000 newly planted sweet orange trees planted in an experimental grove near Taipei in 1967 and has now been in operation for five years. Regular weekly observations have been made in that groves since 1967 but no actual insect counts were made. The following six pests appear to have been adequately controlled by the systemic material : spiraea aphid, citrus black aphid, cotton aphid, leaf miner, rust mite and red mite ; while the citrus dogs have been under control because of the activities of *Telenomus* sp. and *Trichogramma australicum* Giraut. During the past five years there were no outbreaks of the Florida red scale, (*Chrysomphalus ficus* Ashmead) , green scale, mealy bug, citrus spiny whitefly (*Aleurocanthus spiniferus* Quaintance) , citrus psylla, (*Diaphorina citri* Kuwayama) , stink bug and cottony cushion scale. There is no apparent difference in fruit yield when compared to citrus groves executing a standard pest control programme. Fruit samples taken 21, 23 and 45 days before harvest following a season of 3-7 applications of azodrin revealed residues below 0.1 ppm.

The standard pest control programme in Taiwan consists of 10-14 combination sprays of parathion (or other organo-phosphorous compounds) and acaricides, costing US\$ 175 (NT\$ 7,000) per ha for spray material. The cost of four applications of azodrin amounts to US\$ 75, a considerable saving.

臺灣柑橘害蟲防治及新的綜合防治方法¹

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大陸之四種重要柑桔害蟲尚未發現於臺灣。矢根介殼蟲民國24年最初發現於臺灣，旋即根治之，得免後患。最近15年來，普遍地經常使用現代殺蟲劑於柑桔園中，重要柑桔害蟲已得有效防治。柑桔紅蜘蛛之為害過去原本輕微，但是現在日趨嚴重，一躍而為主要害蟲，且經施用證明大部份殺蟎劑防治效力很低。愛速靈當柑桔葉芽開始出現時及7~10天後，塗刷於樹幹上，可防治各種蚜蟲、粉介殼蟲、軟體介殼蟲、有殼介殼蟲、椿象、潛蛾、木蝨、吹綿介殼蟲及銹蟬。在1,000餘株柑桔實驗園中，五年來實驗與觀察發現並無副作用。在此實驗園中，二種捕食性甲蟲非常活躍，顯示能有效的控制柑桔紅蜘蛛，無另作防治之必要。

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