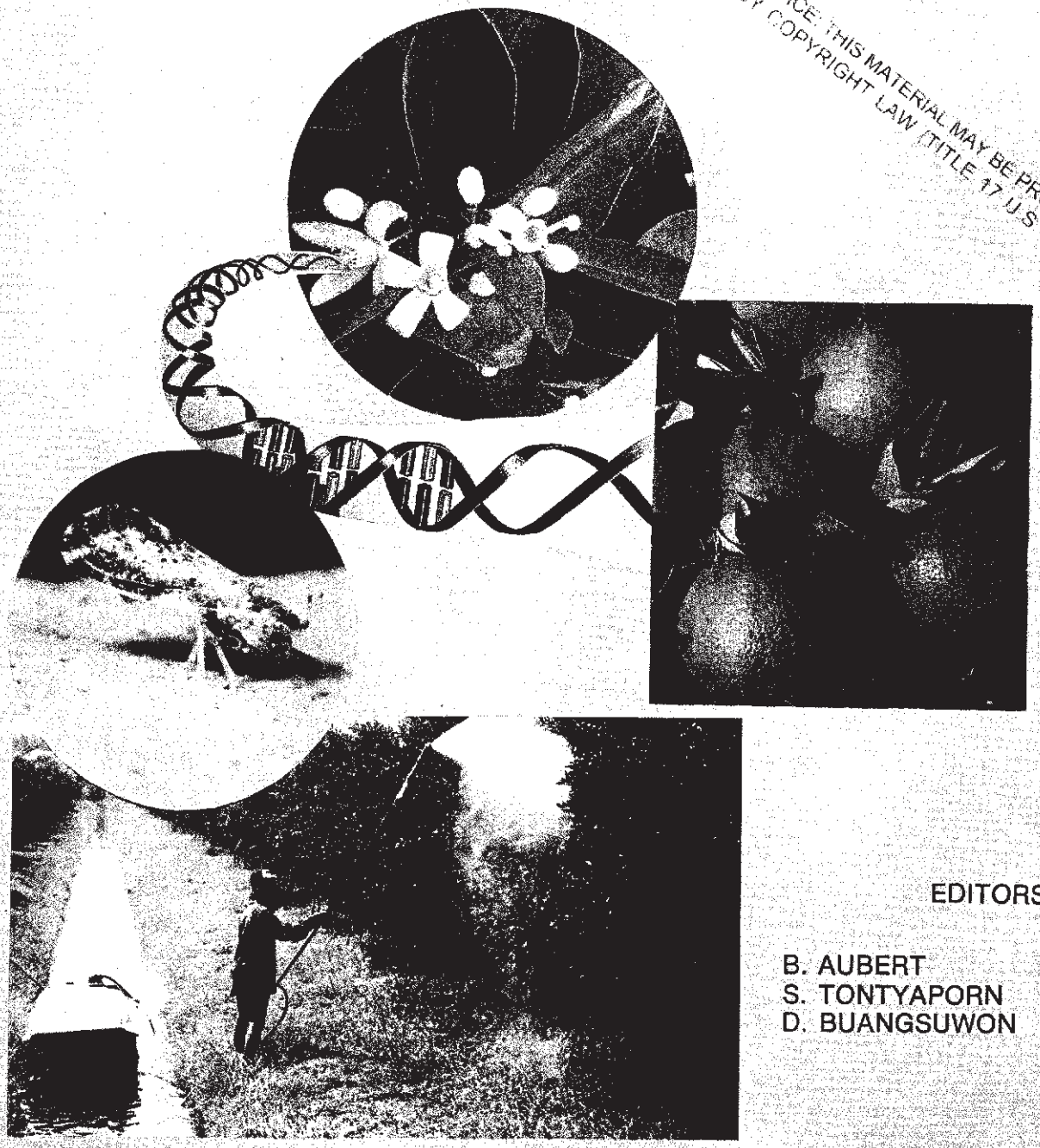
REHABILITATION OF CITRUS INDUSTRY IN THE ASIA PACIFIC REGION

Proceedings of the Asia Pacific International Conference on Citriculture

Chiang Mai Thailand 4-10th February 1990

UNDP-FAO Regional Project RAS/86/022



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Proceedings of the 4th International
Asia Pacific Conference on Citrus Rehabilitation
Chiang Mai, Thailand, 4-10th Feb. 1990

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MONITORING FLIGHT ACTIVITY OF *DIAPHORINA CITRI* ON CITRUS AND MURRAYA CANOPIES

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Abstract

Maximum flight activity was monitored during early summer sunny days above Murraya paniculata canopies in Fuzhou. Among the various colours tested for sticky traps, brown yellow gave the optimum response in cloudy weather. Consistent catches were obtained 5 meters above the top of M. paniculata canopies, but D. citri activity was comparatively much less important above citrus canopies. Windless sunny afternoon of early May between 4 p.m. and 6 p.m., produced the highest flying activity. The proportion of females monitored on the brown yellow traps ranged from 58% to 80%. Stress factors linked to extreme seasonal population abundance may explain the higher activity over M. paniculata canopy.

D. citri is strongly phototaxic and reacts more to light source than colour. Therefore careful spatial distribution of the catching points is an important component for reliable trapping.

1. Introduction

Although widespread in Asian citrus orchards and *Murraya* shrubs, *Diaphorina citri* Kuwayama is thought to be a weak flyer. But its apparent limited dispersal power is currently compensated by an efficient dissemination through the movement of infested citrus material, and this has accounted vastly for the present geographical distribution of the Oriental Citrus psylla. A typical example is the presence of *D. citri* in Brazil, on a Continent where no indigenous *Diaphorina* species is known to occur.

D. citri displays a significant lower ubiquity than its equivalent insect pest in Africa: *Trioza erytreae* (Del Guercio). While the latter is reported to colonize entire forest areas South of Sahara beyond a certain altitude threshold (Samways 1990), the natural habitat of *D. citri* does not usually include Indo Malayan forests.

But to date, very little information is available on the flying behaviour of *D. citri*, although such a knowledge would be of great significance for citrus growers.

The present study aimed to investigate several aspects of *D. citri* flight activity within or above the canopy of two common host plants: *Citrus reticulata*, *M. paniculata*, and to evaluate the risks of passive transport by wind drift.

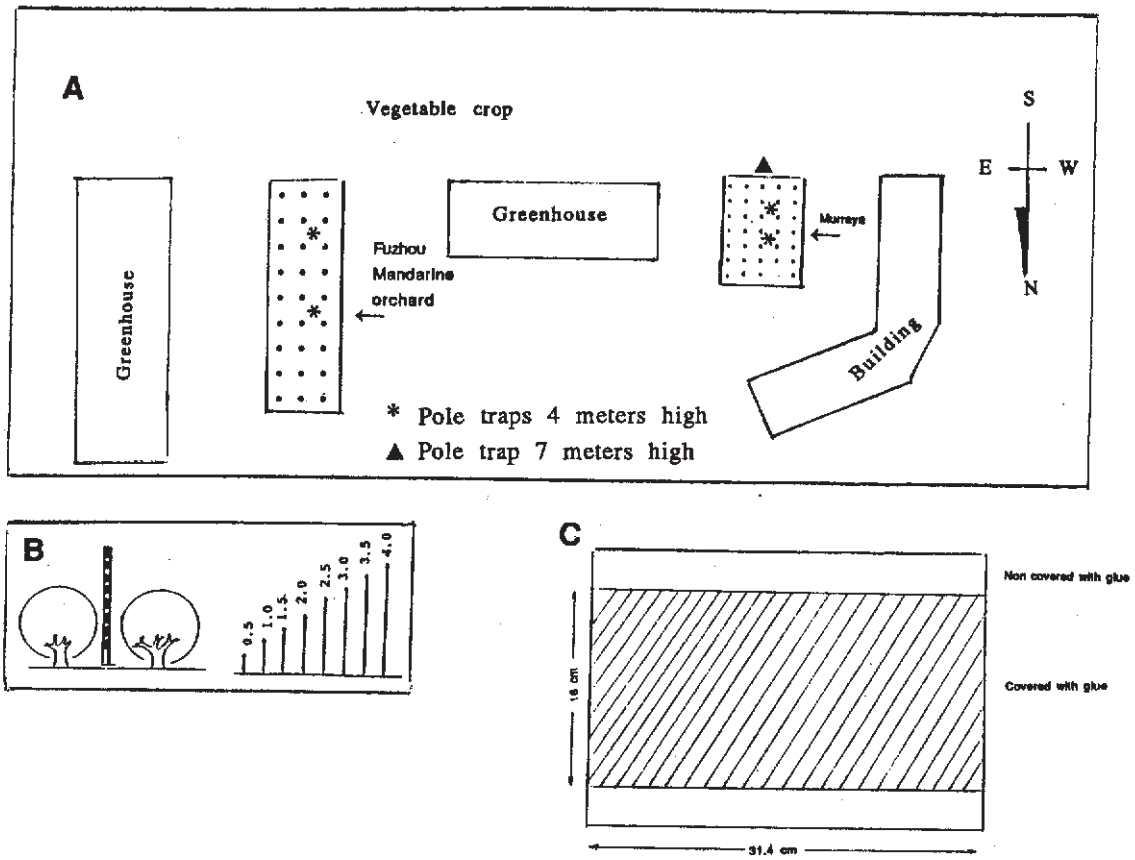

Fig. 1: Monitoring of the vertical flight activity of D. citri above the canopies of mandarin of M. paniculata 4 years old trees
A) General layout of the experiment
B) Cylindrical pole trapping on mandarin trees
C) Developped cylindrical yellow sheet

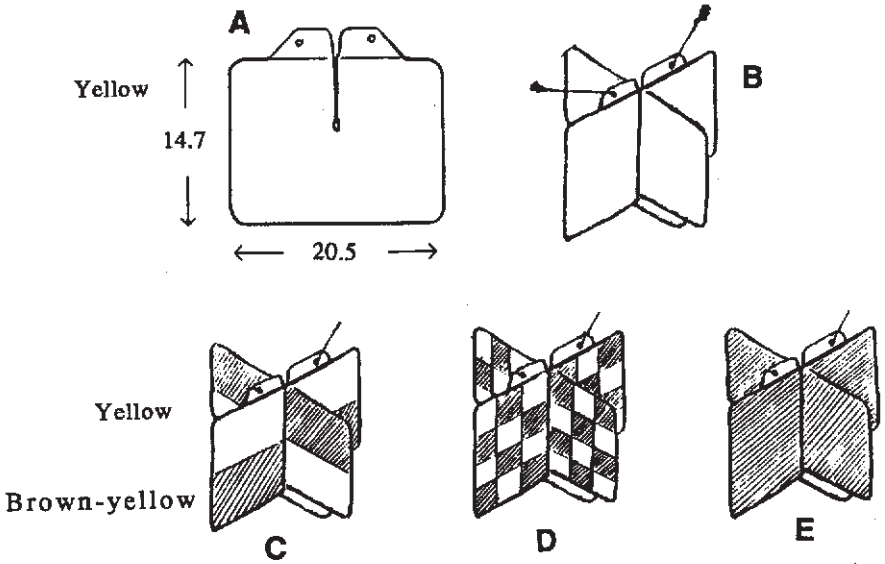

Fig. 2: Rebell© traps used for field testings of colour attractivity
A) Single rigid plastic panel
B) Assembled panels ready for use
C) sixteen differential yellow/brown areas traps
D) Ninety six differential yellow/brown areas traps.
E) Uniform light brown Rebell© trap.

Various trapping experiments were also conducted for determining the reflected wavelength of light, giving optimum responsiveness for psylla catches. The results of these experiments are discussed for developing simple and practical trapping techniques at the farm level.

2 Material and Method

Vertical flight activity:

In a vegetable area of about 10 hectares devoid of citrus or rutaceous plants, two small plantations of 30 trees each were realized. Plantation 1 consisted of Fuzhou mandarine, (*Citrus reticulata*), and plantation 2 of *Murraya paniculata*. The two plots were separated by a distance of 30 meters and the experiment started when both plantings had just entered their fourth year and were hosting large colonies of *D. citri*. The average height of *C. reticulata* canopy was 2.5 meters and that of *M. paniculata* 2.0 meters. None of these plots received insecticide application nor pruning. A general layout of the trial is given on Fig. 1A.

In each plot two bamboo poles reaching 4 meters above the soil level were erected vertically. From the base to the top of these poles eight yellow circular traps of a circonference averaging 31.4 cm, with a width of 16 cm were applied every 50 cm (See Fig. 1B and 1C). The traps which derived from the Samways technique consisted of Saturn yellow 3M© adhesive bands covered by a transparent plastic sheet smeared with Staalchems© glue. Insect catches were monitored at each elevation every ten days from April to November 1989.

During the next growing season, from March to May 1990, a longer bamboo pole reaching 7 meters above ground level was established in the *M. paniculata* plot, and the insect catches were monitored between 3 and 7 meters from April to May 1990. For this second experiment brown yellow Rebell traps described below were used, in comparison with Saturn Yellow Rebell traps. Both types of traps were hanged every meter on a single long pole established in the South border of the *Murraya* plot (Fig. 1A).

Colour attractivity:

Colour gradient "Rainbow" sheets ranging from yellow to green colour were used in narrow band as described by Quilici and Trahais (these Proceedings).

A second set of experiments was initiated with the Rebell© insect trap as a support. These traps were obtained from V. Remund, Swiss Federal Research Station CH 8820 WADENSWILL Switzerland, and consisted of two rigid plastic panels which can be assembled as described on Fig. 2A and 2B. Each panel has a dimension of 20.5 x 14.7 cm, thus giving a total usable trap area of 1,200 square centimeters, or 12 square decimeters.

The Rebell structure was used for experimenting the following colours in outdoor experiments:

- Saturn yellow, Bright yellow, Orange yellow and Brown yellow
- White and Black

These colours were applied uniformly on the two panels of candidate traps.

The five different colour traps were hanged on a wire fixed at a distance of 50 cm above the canopy of the *M. paniculata* plantation. Five replicates were made: four sets in the N-S-E-W directions and one in the center of the plot.

After having noticed a strong response for the Brown Yellow, we experimented dual colour traps (Yellow + Brown Yellow), in two different combinations. One combination consisted of sixteen subunits of 7.4 x 10.2 cm on which both type of colours

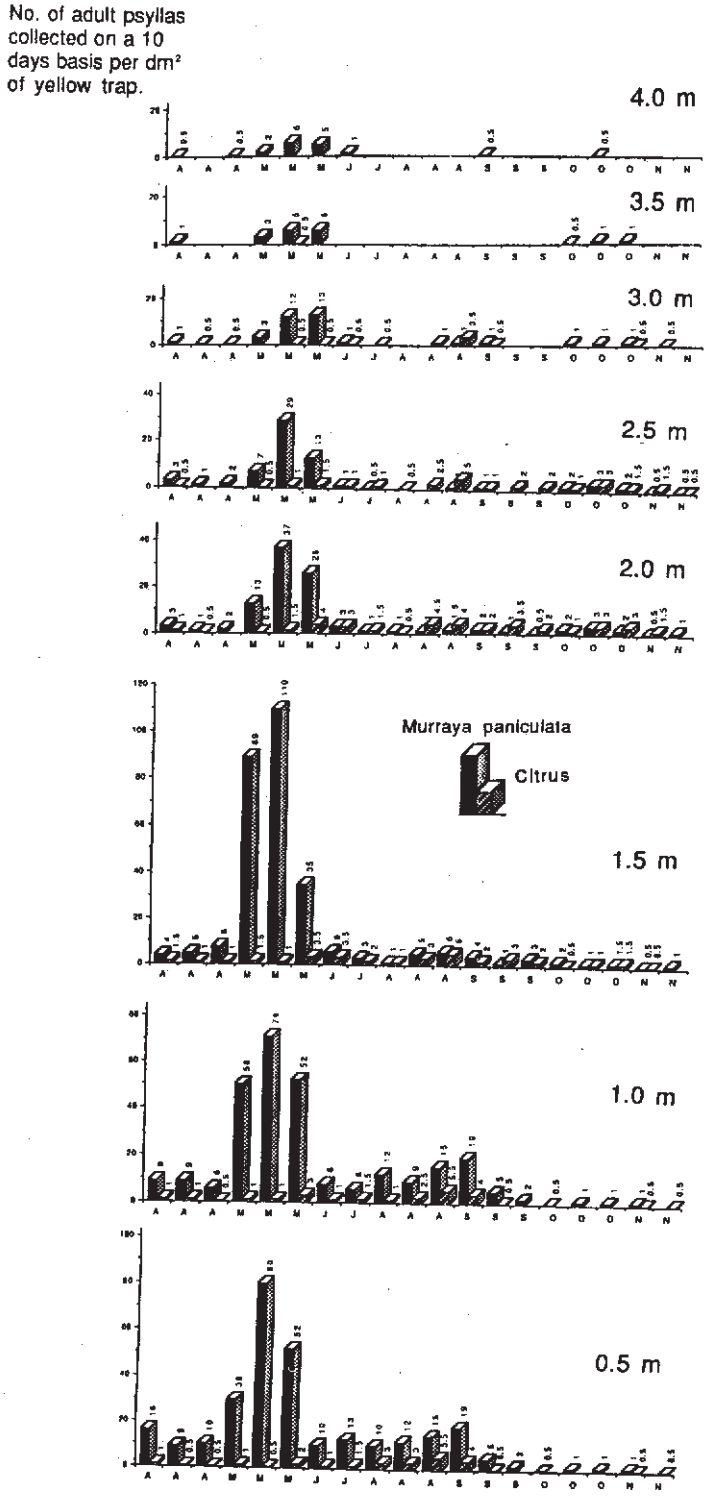

Fig.3: Seasonal fluctuations of Diaphorina citri trappings, at different elevations within and above the canopy of *Murraya paniculata* and *Citrus* (Saturn Yellow cylindrical traps, April to May 1989)

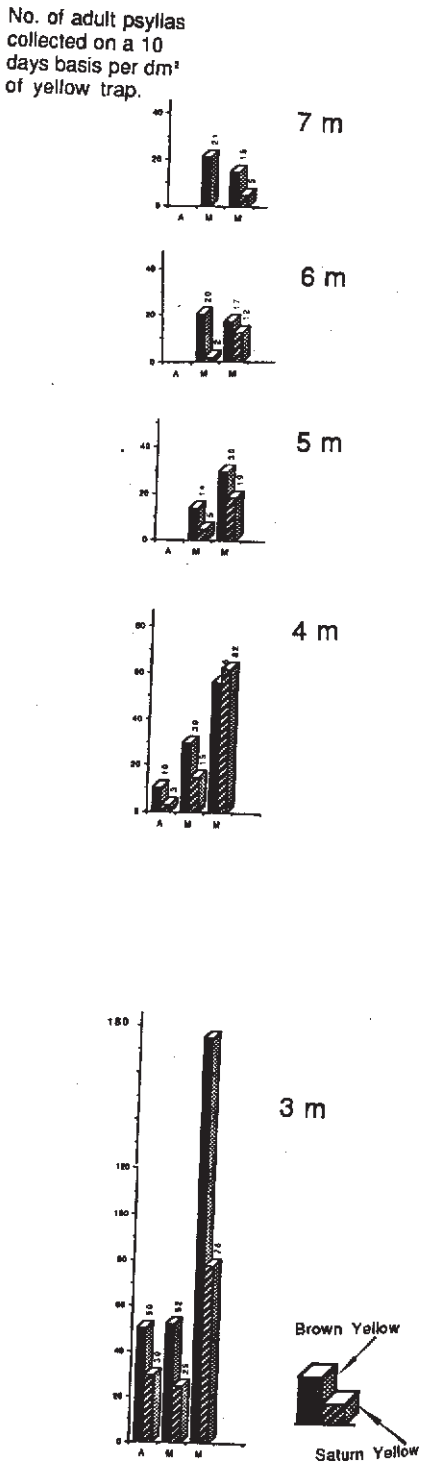

Fig.4: Trap catches above *M. paniculata* in last April and May 1990. Comparison of Brown Yellow and Saturn Yellow catches between 3 and 7 meters.

appeared in contrast. The second arrangement comprised ninety six subunits of 3.4 x 4.9 cm each, on which the Yellow and Brown Yellow appeared also in contrast (Fig. 2D). The chequered yellow brown trap performances were compared with that of uniform Brown Yellow traps (Fig. 2E). These experiments were also conducted outdoor in the experimental plots. But in addition several tests were made in a neglected commercial citrus orchard where colonies of *D. citri* had been found.

Daily monitoring flights:

In Fuzhou the seasonal peaks of *D. citri* populations appear by the middle of May for *M. paniculata*, and in July-August for citrus. Since the concentration of adult psyllids is far more important on the former host plant, we selected *M. paniculata* canopy for daily hour monitoring (from May 1st to 10th). Every two hours, *D. citri* adults caught on sticky traps were counted and removed. Morning and afternoon flights, were compared either on bright sunny days, cloudy or rainy days, and under various conditions of winds.

3. Results

Pole cylindrical Saturn Yellow traps (0.5 to 4m high):

The first pole trapping experiment which was designed for monitoring *D. citri* activity up to 4 meters high, produced various informations which appear on Fig. 3 and can be summarized as follows:

- The second decade of May coincides with the highest *D. citri* activity for *Murraya*, while for citrus, August-September yielded the highest catches.
- Trap catches above *Murraya* canopy went up to 100 times as that above citrus canopy.
- Consistent flight activity occurs at 2 meters above the *Murraya* canopy (4 meters above ground) in May, with other occasional flights in early April, as well as in September and October.
- No activity was recorded at this elevation above Citrus canopy although the latter was 0.5m higher than that of *M. paniculata*.
- The highest catches were obtained at 1.5m. This figure can be interpreted as the result of **jumping-landing** activity which is a predominant behaviour in *D. citri* populations.
- The two bamboo pole traps established in a given canopy, produced very similar results.

Pole Brown Yellow and Saturn Yellow (3 to 7m high):

During the last decade of April and the two first decades of May, Brown Yellow and Saturn Yellow traps established between 3 and 7 meters in the *M. paniculata* plot on a single large bamboo pole, provided interesting results. The trap catches were significantly higher at 3 m with the brown yellow colour. This colour gave consistent catches of 20 adults/dm^2/10days at seven meters of elevations. The Saturn yellow colour produced lower performances and Fig. 4 illustrates the catching gradient, with the results given on a surface basis, rather than trap basis, for better comparison with Fig. 3.

Colour attractivity:

Preliminary results obtained with the Rainbow narrow bands of 3 x 38.5 cm gave a better response in the full yellow colour. This prompted us to investigate a deeper yellow together with a different structure than narrow colour bands which displayed low responsiveness irrespective of the colour. In fact the Rebell trap design was found much more appropriate for conducting the colour tests, because of its crossed panels offering a large surface exposure from any vision angle over 360 degrees.

When comparing brown yellow colour versus various yellow colours, different pattern of responsiveness were obtained according to the weather conditions. During cloudy weather, a usual prevailing condition at springtime in South East China, significant higher catches of *D. citri* were yielded with brown yellow traps, while saturn yellow performed better for aphids than for psyllas (Fig. 3). Another advantage of the brown yellow was its strong selectivity for the Oriental citrus psylla, thus giving "cleaner" traps with minimum catches of other non target insects, and an easier "reading" of the monitoring.

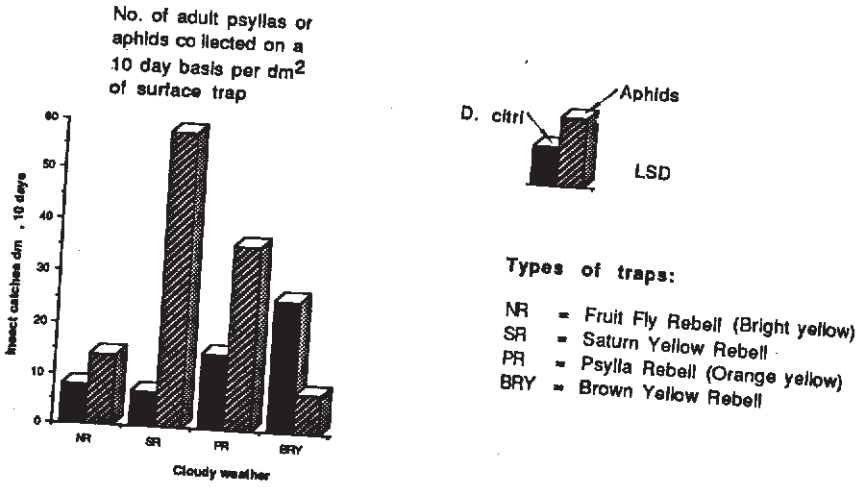

Fig. 3: Average insect catches obtained during springtime in Fuzhou under cloudy weather. Each colour treatment had 5 replicates.

However during bright sunny days, which seldom occur during spring and early summer in Fuzhou, yellow colours gave significant higher catches. Therefore in order to develop a versatile procedure performing correctly under cloudy and sunny days, chequered Yellow + Brown Yellow traps were compared with various other colours uniformly applied on the Rebell structure. The results are presented on Fig. 4, and the following observations were made

- During sunny weather, large chequered yellow + brown-yellow performed best and uniform brown yellow responsiveness was significantly lower. The orange yellow (Psylla Rebell) ranked second but very close to the large checkered design.
- During cloudy weather brown-yellow outran the other colours, and chequered combinations were surprinsingly perceived as less attractive than uniform orange yellow.
- Another type of information which was obtained from this second set of experiments, is the great variation among the replicates following the various background exposures. *D. citri* adults were strongly attracted towards the South and South East directions which offered wider sky vision than North and Northwest directions which were bordered by a two storeys building.
- Studies conducted within citrus canopies produced similar pattern of responsiveness with higher catches of Brown yellow during cloudy weather, and strong tendency of flights opposite to adjacent windbreak.

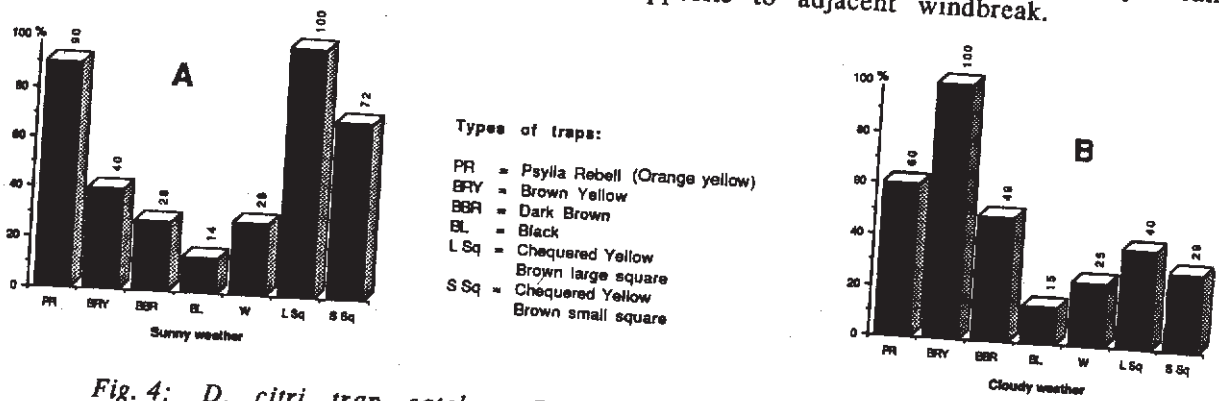

Fig. 4: D. citri trap catches: Responsiveness of seven various colours or chequered combinations, in per cent under sunny or cloudy weather

Daily monitoring flights:

Hourly records were carried out with psylla Rebell traps (Orange yellow) on sunny or cloudy days during the highest *D. citri* upsurges of early May in Fuzhou, on *M. paniculata*. Fig. 5 shows a much stronger activity on sunny days, especially between 4 and 6 p.m. than on cloudy days. It was noticied that flight stimuli for *D. citri* were inhibited by occasional winds of 0.5 to 1m/sec. or above that speed. Mass migrations were suddenly resumed as soon as wind had stopped, and atmospheric conditions were still. The predominant behaviour was **jumping-landing**, but vertical active flight also occurred, especially on sunny windless afternoon. The vertical distance flown was at least 5 to 6 meters above the canopy of *M. paniculata*, and the sex ratio recorded at that elevation showed a predominance of adult females (from 58 to 80%).

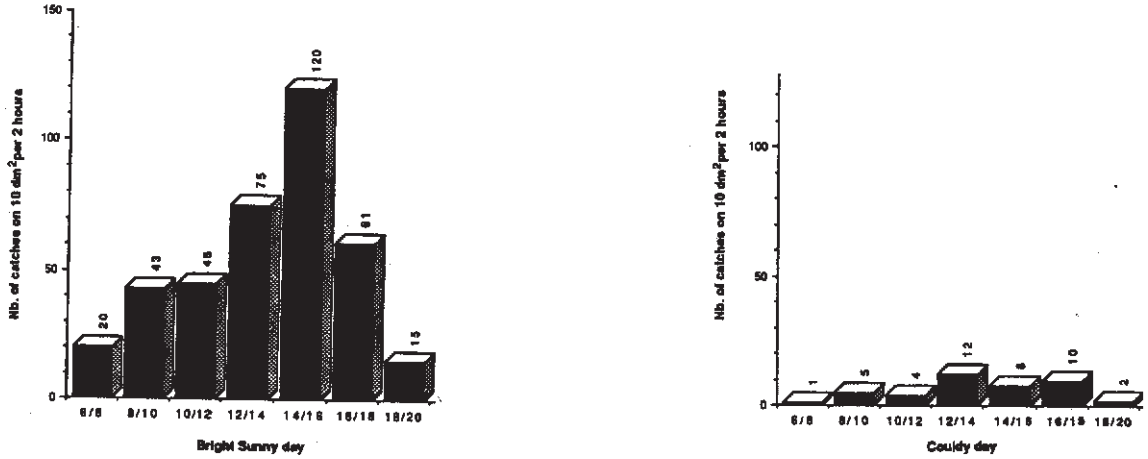

Fig. 5: Hourly D. citri catches in early May Fuzhou on sunny or cloudy weather, 50 cm above Murraya paniculata canopy.

Discussion and conclusion:

In Fuzhou, extreme *D. citri* upsurges appear on *M. paniculata* canopy during the month of May, and are far more important than those recorded on citrus canopy. The results of trap catches obtained during our study indicated consistent vertical flight activity at 7 meters above ground level when *M. paniculata* was dealt with. This is high enough for subsequent medium distance transport by wind drifts over 0.5 to 1 km, depending of windspeed and duration of sustained flight. Therefore it is concluded that *M. paniculata* is a dangerous psyllid host plant and should be carefully eradicated or at least sprayed when established in the vicinity of citrus plantations. Higher flight activity above *M. paniculata* could be related to population stress, a factor mentioned for various insects by Taylor (1986). But components like temperature, photoperiod, light intensity, wind speed are also influencing the movement or migratory behaviour. As a whole, when breeding on specific host plants, the dispersal power of *D. citri* can be similar to that *T. erytreae* (Van den Berg and Deacon, 1988), although its activity seems far more reduced on citrus.

Since chequered traps did not produce the expected versatile responsiveness, it is suggested that trap monitoring be made with two different items: i) brown-yellow traps for cloudy weather, ii) bright yellow for sunny days. The traps must be placed against open background, rather than closed background such as windbreak.

Additional visual scouting on young flushes with handlens is always advisable for routing detection in citrus groves since the trapping technique can only provide partial information.

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