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Monitoring population dynamics of the citrus pock caterpillar (*Prays endocarpa*) by sex pheromone traps in the Mekong Delta of Vietnam

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ABSTRACT

The citrus pock caterpillar (CPC), *Prays endocarpa*, is an important insect pest of “Nam roi” pomelo in the Mekong Delta of Vietnam. In order to establish an efficient timing for a sustainable management program of CPC, monitoring the population dynamics and ratios of infected pomelo fruits at Binh Tan district, Vinh Long province had been conducted by use of sex pheromone traps and field investigation. The CPC adult flight and CPC larval infestation on pomelo fruits presented through out the year. However, high numbers of CPC captured males and ratios of larval infected fruits were observed in the dry season (from November to May) indicating the generation overlapping and negative effect of rainfall on the CPC population. Closely (tight) positive correlation between numbers of captured CPC males by pheromone traps and ratios of larval infected fruits with the correlation coefficient r of 0.77 ($P = 0.00000364$, one tailed probability or 0.00000727, two tailed probability); $df = 23$) and the regression equation of $y = 0.3283x + 7.1766$ revealed that numbers of males captured by sex pheromone traps can be used for estimation of the action threshold for CPC.

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1 INTRODUCTION

Pomelo (*Citrus maxima* Merr.; Synonym: *C. grandis* Osbeck; *C. decumana* L.) is the largest citrus fruit originated from South-East Asia with at least 22 varieties which have been described (Morton, 1987). There are several pomelo varieties such as Da xanh, Nam roi, Long in the Mekong Delta of Vietnam, amongst these “Nam roi” is one of the most cultivating varieties with the planting area of more than 9,200 ha.

The citrus pock caterpillar (CPC), *Prays endocarpa* Meyrick (Lepidoptera: Yponomeutidae: Praydinae),

is one of the most important pests of pomelo in South-East Asia (Waterhouse, 1993). In the Mekong Delta of Vietnam, CPC was recorded as serious damage on “Nam roi” pomelo variety, while its attack was trivial on the others such as “Da xanh” and “Long” pomelo varieties (Nguyen Van Huynh and Le Thi Sen, 2011; Nguyen Thi Thu Cuc, 2015). Newly emerging CPC larvae mine in the peel of pomelo fruits causing premature fruit fall or making tumors on the fruit peel (when the attack happened at later fruit development stage), which caused strong decrease of the commercial value of the fruits (Vang *et al.*, 2011). Because the CPC larvae feed inside the fruits, effective control must be carried

out at a very short period when they are still staying outside the fruits. Therefore, monitoring of the population dynamics to supply data for timing of intervention is important for effective control of CPC.

Sex pheromones were considered as an efficient tool for monitoring the insect population dynamics, particularly for lepidopterous species (Ando and Yamakawa, 2011). Correlation between numbers of captured males by sex pheromone traps and ratios of infected fruits was used effectively for determining the action threshold of the obscure mealy bug, *Pseudococcus viburni* (Signoret) (Homoptera: Pseudococcidae), damaging pome fruit orchards in the Western Cape Province of South Africa (Mudavanhu *et al.*, 2011). Therefore, using sex pheromone traps combining with field investigation is expected to be the useful tools for timing control of CPC in the Mekong Delta of Vietnam. Sex pheromone of CPC was identified as (Z)-7-tetradecenal compound (Z7-14:Ald) by GC-MS (Gas Chromatography - Mass Spectrometry) analysis of the abdominal tip extracts and following examinations of the attraction in the field (Vang *et al.*, 2011). Procedure for synthesis of Z7-14:Ald was described by Le Van Vang *et al.* (2006).

In order to establish an efficient timing for a sustainable management program of CPC in the Mekong Delta of Vietnam, this study on the monitoring of population dynamics and ratios of larval fruit infestation of CPC by using sex pheromone traps and field investigation had been conducted in three hamlets at Binh Minh district, Vinh Long province.

2 METHODS AND MATERIALS

2.1 Chemicals

Synthetic Z7-14:Ald was supplied from the previous

research by Vang *et al.* (2011). Before using for preparation of lure, the material was purified by an open column chromatography on a stationary phase of 15% AgNO₃ in silica gel (Merck).

2.2 Investigation of CPC larval fruit infestation

The infestation of CPC larvae on pomelo fruits was investigated in six pomelo orchards located at Dong Hoa, My Phuoc and My Hung hamlets at Binh Tan district, Vinh Long province (Table 1). In each investigated orchard, 15 pomelo trees distributed evenly over the orchard area were marked with red stripes. The infected fruits were examined by inspecting their peels. All the fruits on the marked trees were examined every two weeks for one year.

2.3 Field capture of CPC males

Lure preparation and trap setting in pomelo orchards were conducted as previously described by Vang *et al.* (2011). Briefly, a rubber septum (8 mm o.d., white rubber; Aldrich Chemicals, Milwaukee, WI, USA) impregnated with 1.0 mg of synthetic Z7-14:Ald compound (without anti-oxidation or stabilizer) was placed at the center of a delta sticky trap (30×27 cm bottom plate, Takeda Chemical Ind., Ltd., Osaka, Japan). Traps were hung on a pomelo tree at about 1.5 m height from the ground. CPC males captured by traps were counted every two weeks and at the same time as recording of the fruit infestation. Lures in traps was renewed approximately every 6 weeks. The experiment was carried out in three of six pomelo orchards which were used for investigating the CPC larval fruit infestation (Table 1). Three sex pheromone traps were placed in one orchard.

Table 1: Characteristics of pomelo orchards used for investigation of the CPC population dynamics and ratios of infected fruits

| Pomelo orchard | Location (hamlet) | Area (m ²) | Year after planting | Trees /ha | Use for assessment of | |
|----------------|-------------------|------------------------|---------------------|-----------|-----------------------|----------------|
| | | | | | CPC infestation | Pheromone trap |
| Orch.1 | Dong Hoa | 3,500 | 7 | 400 | + | + |
| Orch.2 | Dong Hoa | 5,000 | 5 | 400 | + | - |
| Orch.3 | My Phuoc | 9,000 | 11 | 420 | + | - |
| Orch.4 | My Phuoc | 6,000 | 8 | 420 | + | + |
| Orch.5 | My Hung | 5,000 | 7 | 400 | + | - |
| Orch.6 | My Hung | 8,000 | 9 | 400 | + | + |

+: used; -: unused.

2.4 Data analysis

Data obtained from the experiments were analyzed by a JMP statistical program. Significant differences

between means were compared by Tukey-Kramer HDS Test. In order to homogenize the variance, means were standardized using $\log(x+0.5)$ and $\arcsin\{\sqrt{x+0.5}\}$ transformation.

3 RESULTS

3.1 Counting of infected fruits and captured *Prays endocarpa* males by sex pheromone traps

Table 2 shows the counting of captured CPC males by sex pheromone traps and ratios of infected fruits in pomelo orchards at three different hamlets in

Table 2: Counting of captured CPC males by sex pheromone traps and ratios of infected fruits in pomelo orchards at three different villages in Vinh Long provinces

| Hamlet | Infected fruits (%)* | Males/trap/2 weeks* |
|----------|----------------------|---------------------|
| Dong Hoa | 7.5 ± 2.7 b | 6.7 ± 1.0 b |
| My Phuoc | 14.4 ± 6.4 a | 22.8 ± 4.9 a |
| My Hung | 12.1 ± 4.4 a | 11.8 ± 0.3 b |
| CV (%) | | 20.9 |

* Mean ± SE. values in a column followed by a different letter are significantly different at P<0.05 by Tukey-Kramer Test

3.2 Dynamics of population and infestation of CPC

Results of the monitoring of CPC adult flight and CPC larval infestation were showed in Figure 1. The capture of CPC males and damage of CPC larvae on pomelo fruits presented throughout the year,

Vinh Long provinces. The number of captured males at My Phuoc hamlet was significantly higher than those of Dong Hoa and My Hung hamlets, while ratios of infected fruits were not significantly different between My Phuoc and My Hung hamlets.

indicating a generation overlapping. Otherwise, the numbers of captured males (averagely 20.7 males/trap/two weeks) from November to May were higher than those in the period from June to October (5.6 males/trap/two weeks). This revealed that weather conditions might affect to the density of CPC population.

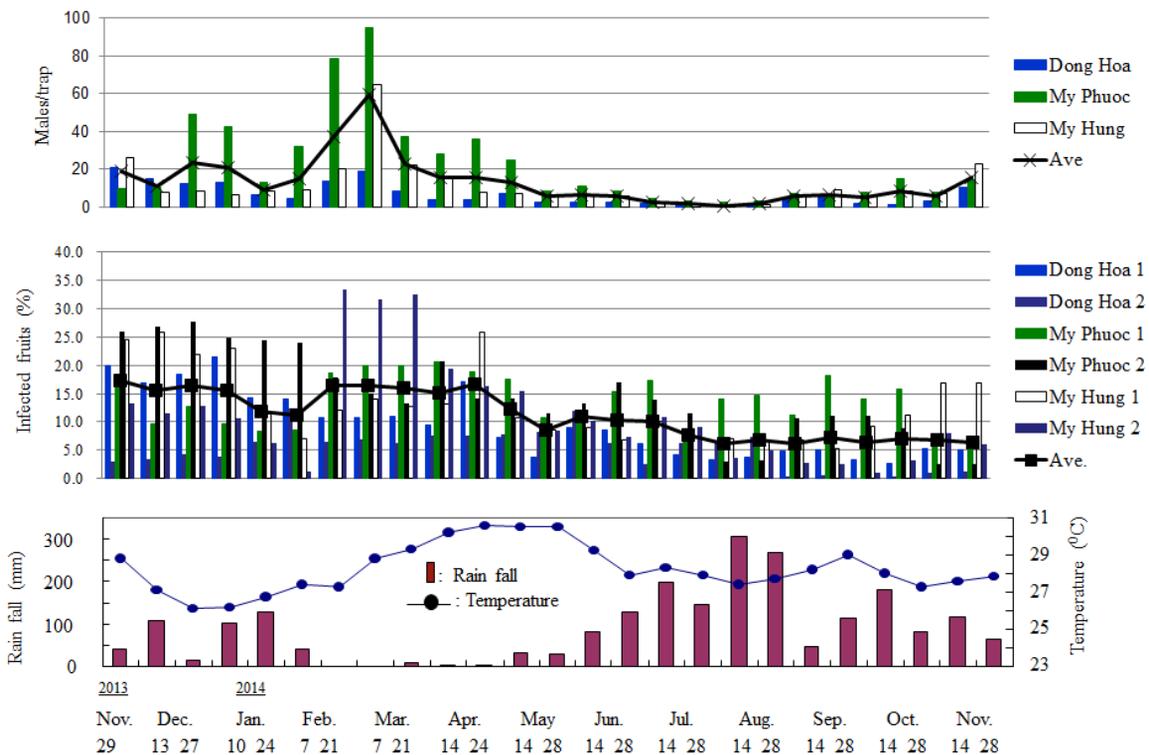


Fig. 1: Dynamics of captured CPC males, ratios of infected fruits, rainfall and temperature at Dong Hoa, My Phuoc and My Hung hamlets (rainfall and temperature were supplied from the Weather Station of Vinh Long province)

The dynamics of ratios of infected fruits was not highly fluctuated as comparing with that of the

captured CPC males. However, the high infestation was also observed from November to April with

average ratio of infected fruits was 15.3%, while the average ratio of infected fruits from May to October was 8.3% (Figure 1).

3.3 Correlation between pheromone trap catch and infestation

The correlation between numbers of captured CPC

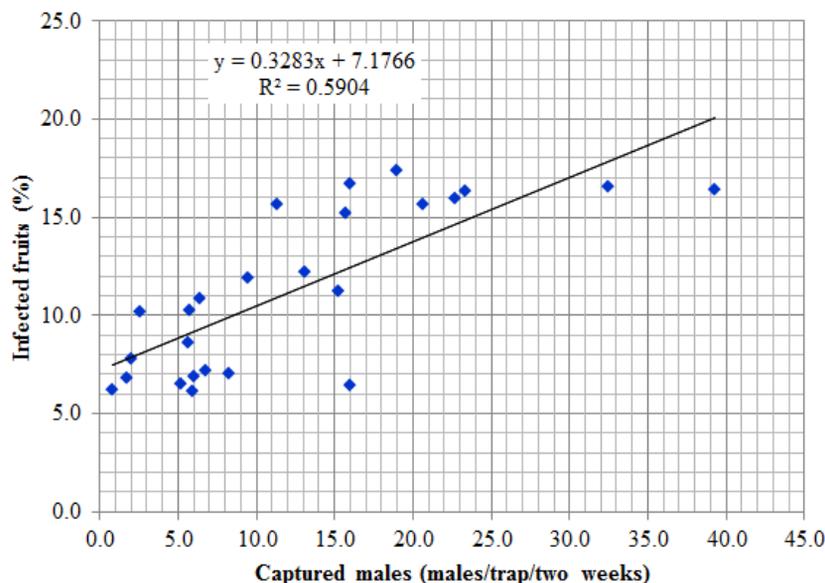


Fig. 2: Correlation between numbers of CPC captured males by sex pheromone traps and ratios of CPC infected fruits at Dong Hoa, My Hung and My Phuoc hamlets, Binh Tan district, Vinh Long province

4 DISCUSSION

Dynamics of CPC captured males and ratios of CPC larval infected fruits were successfully recorded by using of sex pheromone traps and fruit examination in pomelo orchards at Dong Hoa, My Phuoc and My Hung hamlets in Binh Minh district, Vinh Long province.

The CPC captured males and CPC larval infected fruits were recorded throughout the year. In the Mekong Delta of Vietnam, “Nam roi” pomelo trees bear fruits mainly in two periods, the first is from February to May (main fruiting season) and the second is from September to November. Besides, pomelo fruits were also produced sporadically throughout the year, and thus, the food (host plant) for CPC larvae was also presented throughout the year. Additionally, the fluctuation of monthly average temperature in Vinh Long province was low, within $\pm 2^{\circ}\text{C}$ around 28°C (Figure 1). These produced conditions for CPC population growth and generation overlapping. According to Nguyen Thi Thu Cuc (2015), a life cycle of CPC was about 26 days. However, both numbers CPC captured males and ratios of infected fruits were higher in the dry season (from

males by pheromone traps and ratios of larval infected fruits was positive with correlation coefficient r of 0.77 ($P = 0.00000364$ (one tailed probability) or 0.00000727 (two tailed probability); $df = 23$) and the regression equation was $y = 0.3283x + 7.1766$ (Figure 2).

November to May) as comparing with that of in the rainy season (from June to October) (Figure 1) indicating that the reason for low numbers of captured CPC males and ratios of CPC larval infected fruits during the rainy season might be the effect of the rainfall.

Otherwise, the numbers of captured CPC males and ratios of CPC larval infected fruits in My Phuoc were higher than those of Dong Hoa and My Hung hamlets (Table 1). In Vinh Long province, “Nam roi” pomelo planting area was concentrated highly in Binh Minh district with more than 3,000 ha, in which My Hoa village was accounting for 43.3% (1,300 ha) (Vinh Long Department of Statistics, 2016). Amongst the three experimental sites, My Hung and My Phuoc hamlets belong to My Hoa village while Dong Hoa hamlet belongs to Dong Thanh village. At My Phuoc hamlet, “Nam roi” pomelo was cultivated as monocropping farming, while orchards at My Hung and Dong Hoa hamlets were intercropping of pomelo with other fruit trees such as oranges, rambutan, longan, guava. The levels of intercropping farming increased from My Hung to Dong Hoa hamlets. These revealed that monocropping farming of pomelo promoted the high number

of CPC captured males and ratios of CPC larval infected fruits at My Phuoc hamlet.

The correlation between ratios of CPC larval infected fruits and numbers of CPC captured males by synthetic pheromone traps was significantly positive with the correlation coefficient r was 0.77 (Figure 2). This indicated that numbers of CPC males captured by pheromone traps are able to be used as data for estimation of the ratios of infected fruits, from which a threshold action or timing of intervention can be obtained. In order to avoid misusing as warned by Bewick *et al.* (2003), correlation between numbers of CPC captured males and ratios of infected fruit at each surveyed site was also calculated, all were positive. Use of correlation between the numbers of captured males by sex pheromone traps and fruit infestation for decision of action threshold for the obscure mealy bug, *Pseudococcus viburni* (Signoret) (Homoptera: Pseudococcidae), damaging pome fruit in the Western Cape Province of South Africa was reported (Mudavanhu *et al.*, 2011). In the genus *Prays*, sex pheromones have been identified from four species including the citrus flower moths (*Prays citri* and *P. nephelomima*) (Nesbitt *et al.*, 1977; Gibb *et al.*, 2005), the olive moth (*P. oleae*) (Campion *et al.*, 1979; Renou *et al.*, 1979) and CPC (*P. endocarpa*) (Vang *et al.*, 2011). Amongst of these, CPC was the only species in *Prays* genus of which correlation between numbers of captured males by sex pheromone traps and ratios of infected fruits has been investigated by this research.

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