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DYNAMICS AND DISTRIBUTION OF *Diaphorina citri* (Hemiptera:Psyllidae) IN A CITRUS ORCHARD IN TERENGGANU, MALAYSIA

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Abstract

Population fluctuation of Diaphorina citri was monitored once every four week for a period of seventeen months from March 2011 – July 2012, in a pesticide free citrus orchard. High number of adult D. citri were found on the upper canopy, north cardinal point and leaves growth stage 1. D. citri adults and immatures were found on C. suhuinensis on all sampling dates, except in the months of December, 2011 and January and May 2012, for immatures. Peak population of D. citri adults were found in months of March and June in both years, while in immatures peak populations were identified in the months of July, 2011 and March, 2012. Correlation analysis of D. citri adults and immatures with flush growth leaves and weather parameters shows adult D. citri population to correlate with number of flush leaves (r = 0.93) and temperature (r = 0.45). While immature D. citri population only correlated with flush leaves. Findings of these study give an insight into dynamics of D. citri populations in citrus orchard, which is usefull in monitoring and management of the pest.

Key words**:** *citrus*, *Diaphorina citri*, *Malaysia, population fluctuation.*

INTRODUCTION

Diaphorina citri Kuwayama (Hemiptera: Psyllidae) is one of the most important pest of citrus (Sule et al., 2012a) its ability to vector the bacteria that cause citrus greening or huanglungbing disease make it the most destructive pest of citrus globally (Sule et al., 2012b; Hall et al., 2011).
Adults and nymphs of the psyllids transmit the disease through feeding and citrus tree infected with greening diseases produce bitter, inedible, and misshapen fruits and eventually die within 5–10 years of infection (Mann et al., 2010).
Many factors are responsible in the occurrence and development of *D. citri*. Temperature, relative humidity and rainfall are the main factors that influence the development of *D. citri* population (Aubert, 1987). Fluctuations in population of psyllids are closely related with the occurrence of new young flush, but outbreak of the psyllids can occur at any time of the year, once environmental conditions are favourable and young flush leaves are available (Hall, and Albrigo, 2007).
Knowledge of the seasonal abundance, trends in the population build up and preferred canopy site by the psyllids has become imperative for effective control schedule against the pest.
Therefore, the objectives of this study are 1) to observe distribution and fluctuation in population of *D. citri* on citrus in relation to environmental factors. 2) To determine preferred canopy strata and cardinal point by the pest.

MATERIALS AND METHODS

Study site

The study was conducted from March 2011 to July 2012 in a pesticide free citrus orchard in Pusat Pertanian Padang Ipoh, Kuala Berang, Terengganu, Malaysia.
The orchard has an area of 20.4 hectares, divided into sixteen blocks. Two Blocks of citrus plant (limau madu), D5 (N 05 02' 57.4" E 103 00' 55.2") and D6 (05 02' 55.6" E 103

00' 54.6") measuring 1.2 hectare and containing 596 citrus trees were selected for the study.

The citrus trees were planted at 5m x 4m spacing and agronomic practices such as weeding and application of manure were given to the citrus plants at regular intervals.

Population sampling

One hundred and thirty five citrus trees of similar size (1.6m – 1.7m high) making 25% of the total trees planted in the two blocks were selected randomly as sample trees. One sampling visit was made every four weeks for a total of seventeen sampling visits to survey population of *D. citri* in the selected trees from March 2011 to July 2012.

The canopy of each tree was partitioned in to two strata; upper and lower, thereafter each stratum was divided into four quadrants (Compass direction), namely north, south, west and east. From each quadrant three shoots were randomly selected during each sampling visit for observation, counting and recording the number of *D. citri* (immature and adults), also number of flush shoot and leaves growth stage on which *D. citri* adult occurred were counted and recorded.

Data Analysis

Population distribution of *D. citri*

To determine whether mean population of *D. citri* adults differed significantly between the two canopy strata (upper and lower), the cardinal points (North, South West and East) and on the different growth stages of *C. suhuiensis* leaves.

The number of *D. citri* counted on the canopy strata, cardinal points and leaf growth stage during each sampling visits were subjected to analysis of variance using computer software SAS 9.1 for windows. Least significant difference (LSD) at 0.05% level of probability was used to separate the means.

Population fluctuations of *D. citri*

Population fluctuation of adults and immature *D. citri* were determined by plotting the total number of adults and immature stages of *D. citri* per sampling visit against time, the number of flush growth leaves (leaf growth stage 1 and 2) and weather parameters; mean monthly temperature and relative humidity and total monthly rainfall and rainy days. The total number of adults and immature *D. citri* were also correlated with flush growth leaves (leaf growth stage 1 and 2) and weather parameters; mean monthly temperature and relative humidity and total monthly rainfall and rainy days, further stepwise regression was performed between observed population and observed environmental parameters (rainfall, rainy days, temperature and relative humidity) and flush leaves growth stage.

RESULTS AND DISCUSSIONS

Population distribution of *D. citri*

The population distribution of adult *D. citri* in relation to tree canopy strata is presented in Figure 1. Significantly ($P < 0.05$) high numbers of adult *D. citri* were found in the upper canopy compared to the lower canopy.

When cardinal points is been considered, significantly ($P < 0.05$) high number of adult *D. citri* were recorded in the northern cardinal point (Figure 2) although not different statistically with the number of adult *D. citri* recorded in the western cardinal point, and the least population of adult *D. citri* was obtained in the southern cardinal point which was not different from the number obtained in western and eastern cardinal point statistically.

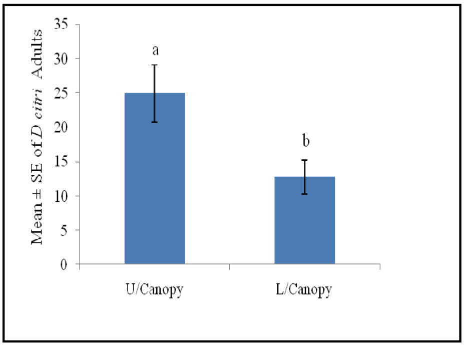

Figure 1. Effect of tree strata on distribution of adult *D. citri*

Similar results were obtained earlier (Albertus et al., 2008), using citrus and orange jasmine plant; however their studies report a no significant difference in population distribution of *D. citri* among cardinal directions (north, west, south and east), on both citrus and orange jasmine trees.

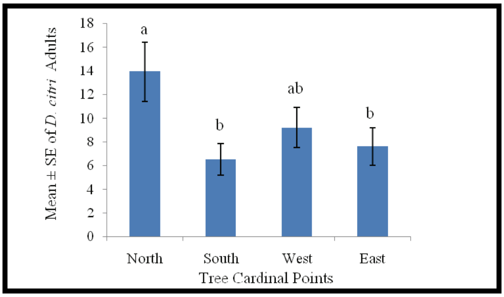

Figure 2. Effect of cardinal point on distribution of adult *D. citri*

Also studies by (Van den Berg et al., 1990) on dispersal of citrus psylla, *Trioza erytreae* indicated that during winter and summer months more citrus psylla were trapped in northern and southern row edges than in the other rows. The high population of adult *D. citri* on the upper canopy and north cardinal point in the present study is attributed to influence of other physical factors such as exposure to sunlight, temperature and relative humidity

With regard to flush leaf growth stage, significantly (P = 0.001) higher number of adult *D. citri* were recorded in flush leaves growth stage 1, followed by leaves growth stage 2 which was not different statistically with the number of adult *D. citri* recorded in flush growth stage 3 (Figure 3), and the least number of adult *D. citri* was recorded in leaves growth stage 4. The observed high number of adult *D. citri* on leaf growth stage 1 may be attributed to the tenderness of the leaves and colour, psyllid being a sucking pest need a tender tissue which may be easier to insert their stylet for feeding and anchoring their eggs.

Population fluctuations of *D. citri*

Population fluctuations of *D. citri* (adults and immatures) in relation to rainfall, rainy days, temperature and relative humidity are shown in Figure 4 and 5

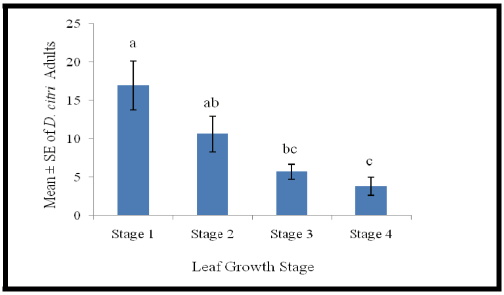

Figure 3. Effect of leaf growth stage on distribution of adult *D. citri*

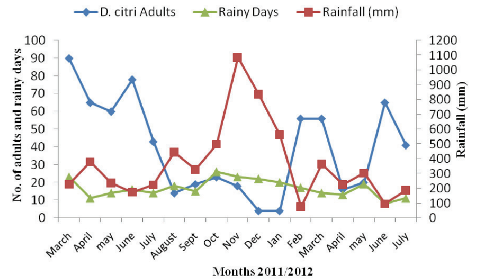

Figure 4. Population fluctuation of *D. citri* adults in relation to rainfall and rainy days from March, 2011 to July, 2012

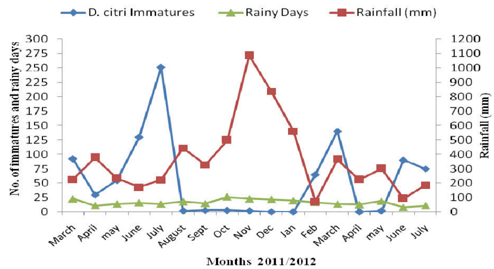

Figure 5. Population fluctuation of *D. citri* immature in relation to rainfall and rainy days from March, 2011 to July, 2012

Population of *D. citri* adults and immatures in the study area from March, 2011 to July 2012 had four and two apparent population peaks appearing in months of March and June, 2011, and February - March and June, 2012 for adult *D. citri* and the months of July, 2011 and March, 2012 for immatures. These population peaks seems to correspond with period when temperature is relatively high and relative humidity is relatively low (Figures 6 and 7) and new flush shoots are available (Figure 8).

The Correlation analysis (Table 1) shows that adult *D. citri* population is significantly correlated with number of flush leaves (r = 0.93) and temperature (r = 0.45). While immature *D. citri* population only correlated with flush leaves.

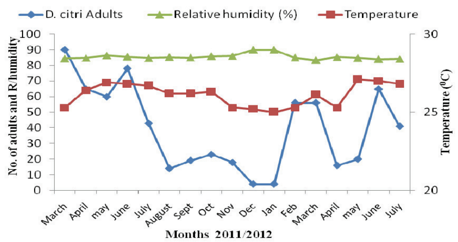

Figure 6. Population fluctuation of *d. citri* adults in relation to temperature and relative humidity from March, 2011 to July, 2012

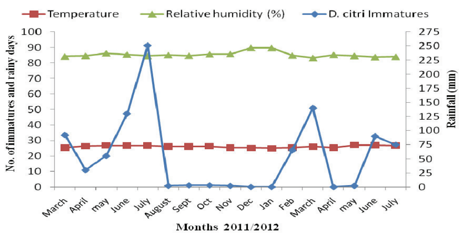

Figure 7. Population fluctuations of *D. citri* immature in relation to temperature and relative humidity from March, 2011 to July, 2012

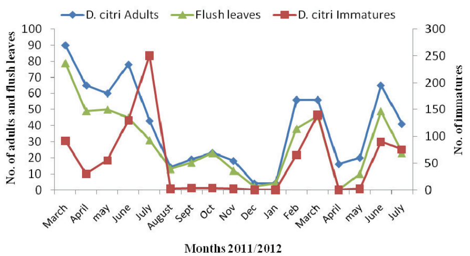

Figure 8. Population fluctuations of immature and adult stages of *D. citri* in relation to number of flush leaves from March, 2011 to July, 2012

However, the stepwise regression analysis between the observed population and the environmental parameters showed that both factors (flush leaves and rainfall) contributed to the population build up/ fluctuation of adult and immature *D. citri* populations, respectively (Table 2).

Population fluctuation of *D. citri* was studied by many authors in citrus and orange jasmine. Psyllid number was reported to be high in the months of May, June, and July in the citrus groves of east-central Florida (Hall, 2009). Qureshi et al., (2009) reported greater number of adult psyllid on citrus trees in April-June in the eastern coastal region, May and July in the southwest region and June, July, and September in the central region of Florida

Table 1. Coefficient of correlation between *D. citri* and environmental factors

D. citri	**Rainfall**	**Rain days**	**Temp.**	**R/Humidity**	**Flush leaves**
Adult	-0.61**	NS	0.45*	-0.52*	0.93**
Immature	-0.62**	NS	NS	-0.65**	0.80**

*significant at P=0.05, **significant at P=0.01, NS=not significant

Table 2. Stepwise regression for *D. citri* against environmental factors

		Regression parameters			
D. citri	Predictor variable	Intercept	Beta	R^2	Significance
Adult	Flush leaves	1.175	0.958	0.918	0.0001
Immatures	Rainfall	138.247	-0.615	0.378	0.009

In the present study, population of *D. citri* (adults and immatures) fluctuated throughout the duration of the study and were generally higher during the dry season in February-July than during the rainy/wet season from August to January. These results were in agreement with those reported by (Leong et al., 2011) and Marcado et al., (1991) which showed population of psyllid to fluctuate in relation to seasonal conditions. Outbreaks in population of Asian citrus psyllids are reported to be most commonly during April-July in Florida (Hall, 2009)

Population fluctuations between periods of times could occur as a result of difference in temperature, humidity or other environmental factors. During the flushing cycles (February – March, June – July) in the present study, total rainfall was low and irregular with low relative humidity and high temperature , these conditions influenced the physiology of the citrus plant to produce new flush shoots, which in turn provide conducive environment for *D. citri* proliferation. The high number of *D. citri* during the flushing cycles may be associated with high number of flush leaves and low rainfall and relative humidity; this can be observed by looking at the result of correlation analysis of those parameters which showed that rain fall and humidity were negatively correlated with psyllid population (Table 1). Chong et al., (2010) found that the density of adults, *D. citri* on orange jasmine plants was negatively correlated with relative humidity in Coral Gables, while it was positively correlated with relative humidity in Doral, but densities of eggs and nymphs were not correlated to any of the environmental factors recorded in all the communities

CONCLUSIONS

Population of *D. citri* on *C. suhuinensis* are more abundant on the upper canopy and north cardinal points of the tree and the population fluctuate throughout the year with population peaks in the months of February-March and June for adult *D. citri* and the months of July and March for immature *D. citri*. It seems to correspond with period when new flush shoots are available, and rainfall and relative humidity are low. However, number of rainy days and temperature has no significant influence on immature *D. citri* population.

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