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Seasonal Abundance of *Thrips hawaiiensis* (Morgan) and *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae) in Mango Orchards in Malaysia

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ABSTRACT

Investigation on seasonal abundance of mango flower thrips was carried out during a flowering season of December 2008 - March 2009 in a commercially managed mango orchard and a control orchard, where no pesticide was applied to control mango pests. *Thrips hawaiiensis* (Morgan) and *Scirtothrips dorsalis* (Hood) were the most prevalent species in the commercial and the control orchards, respectively. The highest number of adults was significantly found in flowers on the upper canopy, while more immatures were collected from the lower canopy in both orchards. Three major population peaks were discernible for the two species of thrips in this season. The population of *T. hawaiiensis* first peaked two weeks after the onset of flowering in both orchards. Meanwhile, the population of *S. dorsalis* peaked one week earlier in the commercial orchard, but the growth was slower in the control orchard, with the first peak occurring three weeks after the start of the flowering season. Abiotic factors, such as temperature and relative humidity, were found to have significantly influenced the abundance of thrips in this season. The effect of pesticides on the thrips population was also noticeable, with lower abundance recorded in the commercial orchard compared to the control orchard. The findings of this particular research can contribute in improving the management strategies of thrips in mango orchards.

Keywords: Thrips hawaiiensis, *Scirtothrips dorsalis*, seasonal abundance, mangoes

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INTRODUCTION

Mango, *Mangifera indica* Linnaeus (Anacardiaceae), known as the king of fruit (Hussain *et al.*, 2002), is one of the most consumed fruits that occupies about 4565 hectares of agricultural land areas in Malaysia (Kwee & Chong, 1994). Mango suffers from several pest infestations during its growth from seedling until fruit maturity. Nearly 6000 thrips species are currently recognized worldwide (Mound, 2009). Mango flower thrips infest flower panicles, which consequently reduce fruit production and fruit quality (Higgins, 1992; Pena *et al*., 2002). Among the thrips species, *Scirtothrips dorsalis* and *Thrips hawaiiensis* were recorded as severe pests of various vegetables, fruits and ornamental crops in eastern Asia (Seal *et al.*, 2006; Reynaud *et al*., 2008).

As mango is gaining popularity among growers, information on thrips population dynamics is extremely important to better manage its population. This study focused on seasonal abundance and within-plant distribution of thrips, which are crucial for the timing of insecticides application to control this pest and efficient coverage of the chemicals on the panicles. The influence of temperature and relative humidity on population density of thrips will anticipate the severity of its infestation at various ranges of these environmental parameters.

MATERIALS AND METHODS

Study Areas

The populations of *T. hawaiiensis* and *S. dorsalis* were monitored at two mango orchards in Balik Pulau, Penang; a routinely sprayed orchard with pesticides (approximately 2 ha) located at Kampung Perlis and an unsprayed orchard (approximately 0.3 ha) located at Kampung Sungai Burung. Pesticides, such as imidacloprid, cypermethrin, malathion, abamectin, chlorpyrifos and mancozeb, were applied throughout the year in the commercial orchard, but imidacloprid and cypermethrin were only applied during the flowering season.

One- to four-year predominantly MA224 (Chok Anan) mango trees were cultivated in both orchards. Mango trees were planted 4 m apart within rows, with 5.5 m between the rows in the commercial orchard and the distance between rows was 4 m, with 5 m within the rows in the control orchard. Trees were pruned regularly to 150-180 cm in height after fruit harvest to maintain their sizes mainly for ease of the next harvest. The trees were irrigated as necessary through drip tubes in the orchards.

Thrips Sampling using CO_2 Technique

The sampling of the two thrips species, *T. hawaiiensis* and *S. dorsalis* inhabiting within mango panicles, was conducted at weekly intervals during one flowering season. All the samples were collected between 1000 to 1300 hrs, according to the study conducted by Tappan (1986). The panicles from 35 trees of approximately similar size (about 170 cm high) were randomly selected. The canopy of each tree was stratified into two sections, namely, upper (>100 cm from the ground) and lower (50-100 cm from the ground) halves. One panicle was arbitrarily selected from each section. Each panicle was gently covered with a plastic bag, while the thrips within the panicles were immobilized with CO_2 (supplied by Malaysian Oxygen Berhad Sdn. Bhd. in a 25×55 cm cylinder) that was released into the bag through a hose for 30s, and at a flow rate of 3.45 kPa (50 psi).

The time of exposure was determined based on a preliminary trial and after 30 s, most of the thrips in the panicle became inactive and fell to the bottom of the bag. The sample of each stratum was placed in a separate plastic bag, marked with the date and tree stratum. The samples were taken to the laboratory for further analysis. Temperature was recorded using a hand-held thermometer and relative humidity was estimated by a hygrometer within the orchards. In the laboratory, the plastic bags were washed thoroughly with 70% ethanol. The density and species of the thrips per panicle were also recorded.

Microscope slides were prepared based on the methodology described by Mound (2007). Specimens were identified to the species level using the key provided by Moritz *et al.* (2004). Their identification was verified by Dr. Surakrai Permkam, at the Department of Pest Management, Faculty of Natural Resources, Prince Songkla University, Hat Yai, Thailand. A series of voucher specimens were deposited at the Insect Collection Unit, the Laboratory of Entomology, Universiti Sains Malaysia, Penang, Malaysia.

Data Analysis

The mean number of thrips species collected by the CO_2 method from the two orchards was analyzed using student's t-test. The paired t-test was used to compare the densities of thrips species between the upper and lower canopy levels. The association between the thrips population and abiotic factors, such as temperature and relative humidity, was analyzed using linear regression (SPSS, 2004).

RESULTS AND DISCUSSION

Seasonal Abundance of T. hawaiiensis *and* S. dorsalis

Very high abundances of *T. hawaiiensis* (with the total of 24289 and 26490) and *S. dorsalis* (with the total of 14339 and 30721) were collected from the commercial and the control orchards, respectively. *T. hawaiiensis* was dominant in the commercial orchard during the flowering season of Dec 2008 - Mar 2009 (47.47% of the total number of the thrips collected), while *S. dorsalis* (28.02%) was the second most common species. The population of *T. hawaiiensis* grew from a density of 17.72±0.440 per panicle in late December 2008, with the first peak occurring on 8^{th} January 2009 (35.97±1.109 per panicle), which then declined by the third week of January 2009. Its density increased from the last week of January, reaching the second peak on 29^{th} January 2009 (51.29±1.711 per panicle), while the third peak appeared on 19^{th} February (46.60±1.398 per panicle) (Fig.1A).

The number of *S. dorsalis* per panicle fluctuated from 11.84±0.427 to as high as 25.57±1.325 during the flowering season (Fig.1B). The population of *S. dorsalis* peaked one week after the onset of flowering on 1^{st} January 2009. The populations of *T. hawaiiensis* and *S. dorsalis* had three peaks at both the orchards (Fig.1). The period between the first and the second peaks in density was approximately three weeks for both species, reflecting the duration spent to complete one generation. Therefore, both the species completed two population generations during the mango flowering season of Dec 2008 - Mar 2009. Pickett *et al.* (1988) reported that generation peak is an important factor that causes fluctuations in thrips densities.

The most common species in the control orchard was *S. dorsalis,* comprising 24.82% of the total thrips collected, followed by *T. hawaiiensis* (21.40%). The first peak of *T. hawaiiensis* and *S. dorsalis* occurred on 8th January 2009 (53.63±2.496) and 15th

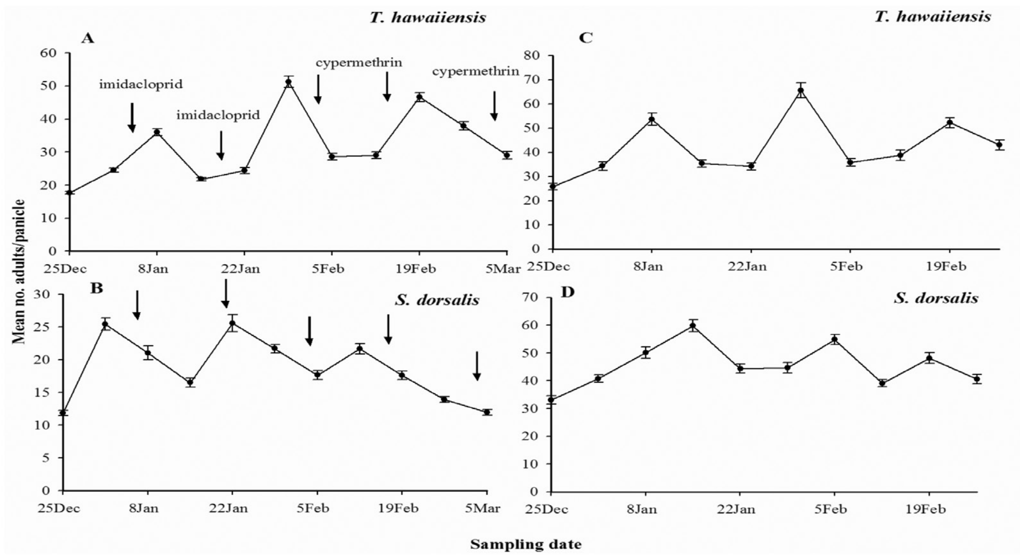

Fig.1: Seasonal abundance of adult thrips species per panicle collected from the commercial orchard (A, B) and those from the control orchard (C, D) during the flowering season (Dec 2008 - Mar 2009)

TABLE 1
The mean (±SEM) number *of the two thrips species collected from the upper and lower canopies of mango trees during the flowering season (Dec 2008 - Mar 2009) in the commercial and the control orchards

Species	Stage	Commercial orchard		Control orchard	
		Upper	Lower	Upper	Lower
T. hawaiiensis	Adult	36.45±3.684	26.63±2.690	52.66±5.798	31.11±2.090
	Instar I	6.50±0.714	8.06±1.001	12.53±1.108	16.20±1.406
	Instar II	8.68±1.169	12.22±1.391	16.47±1.019	19.71±1.100
S. dorsalis	Adult	21.03±1.841	16.21±1.269	52.53±3.407	38.55±2.046
	Instar I	4.11±0.655	5.43±0.727	13.90±1.281	17.12±1.167
	Instar II	4.88±0.597	7.46±0.910	15.98±1.125	18.22±1.138

*Values were mean per sample.

January 2009 (59.80±2.153), respectively. Both the species displayed three peaks of abundance during the flowering season, with the peaks of immatures occurring one week before those in adult abundance.

The seasonal prevalence of thrips for the first and second instar larvae in the mango orchards showed a similar distribution pattern (Fig.2 and Fig.3). Several peaks of occurrence were indicated during the flowering season. The density of larvae within the mango panicles was low in comparison with that of the adults. The declining proportion of larvae in the late flowering season indicates a declining rate of reproduction among females. Fecundity

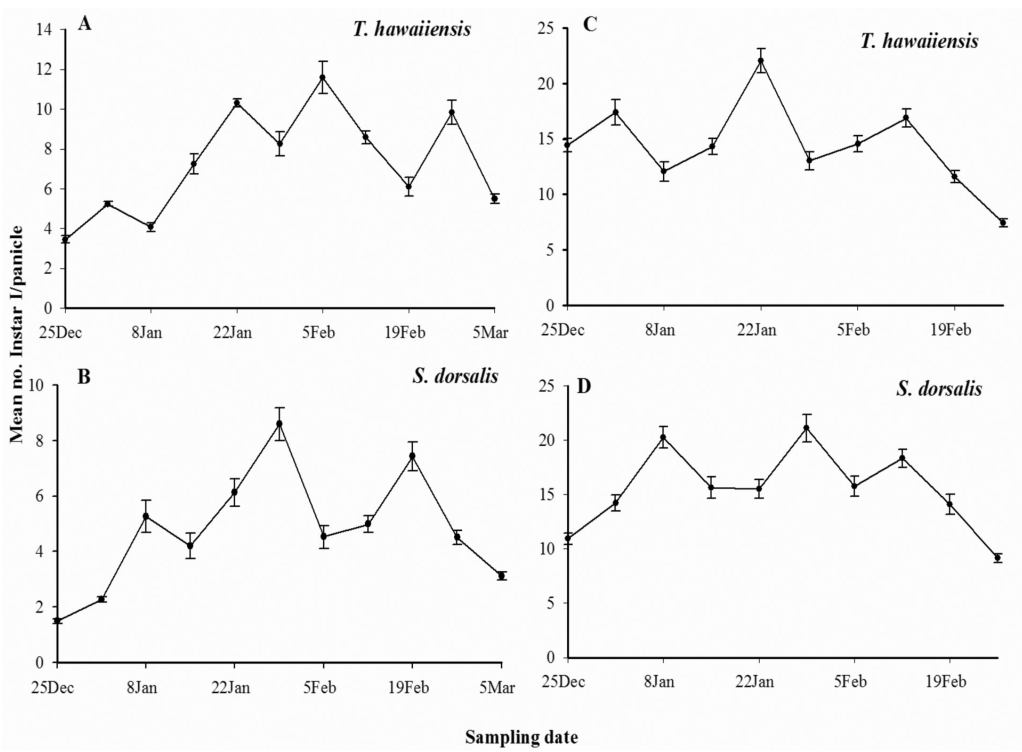

Fig.2: Seasonal prevalence of the first instar larvae per panicle in the commercial mango orchard (A, B) and those in the control orchard (C, D) during the flowering season (Dec 2008 - Mar 2009)

TABLE 2
The mean percentage* of the adult thrips in the upper and lower canopies of mango trees during the flowering season (Dec 2008-Mar 2009) in the commercial and the control orchards

Species	Commercial orchard		Control orchard	
	Upper	Lower	Upper	Lower
T. hawaiiensis	57.784	44.216	62.864	37.136
S. dorsalis	56.466	43.534	57.678	42.322

*Values were mean per sample.

depended on the consumption of pollen grains from flowers, which decreased in numbers in the late season (Pickett *et al*., 1988). Findings of the current study showed the proportion of larva to adult was higher in the control orchard than the commercial orchard. This could be attributed to a higher susceptibility of the larvae to insecticides application compared to the adults.

Meanwhile, the mean number of *T. hawaiiensis* (adults: F=0.16, df=19, P<0.001 and larvae: F=4.02, df=19, P<0.001) and *S. dorsalis* (adults: F=1.80, df=19, P<0.001 and larvae: F= 1.43, df=19, P<0.001) differed significantly between the commercial and the control orchards, implicating that chemical sprays did affect the populations of thrips. The results also indicated that *S. dorsalis* was more susceptible to insecticides pressures as its population was approximately 2.5 folds higher in the control orchard (Table 1).

Within Plant Distributions of T. hawaiiensis and S. dorsalis

Adults of both species were significantly more prevalent in the upper canopy of mango trees than in the lower canopy, while more larval thrips were found in the lower part of the canopy in both orchards (Paired

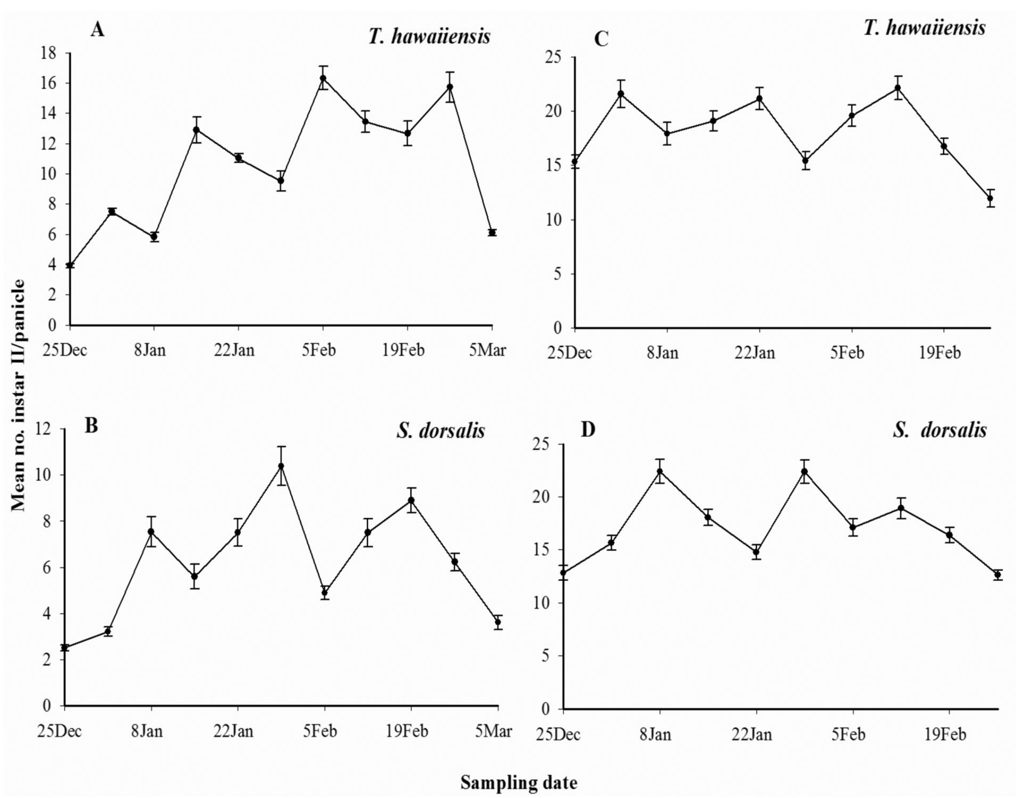

Fig.3: Seasonal prevalence of the second instar larvae per panicle in the commercial mango orchard (A, B) and those in the control orchard (C, D) during the flowering season (Dec 2008 - Mar 2009)

t-test, all $P<0.05$, respectively). However, the patterns of distribution were very similar in the two canopy levels (Table 1).

Salguero-Navas *et al*. (1991) reported higher numbers of *Frankliniella occidentalis* (Pergande) and *F. tritici* (Fitch) in the upper canopy of tomatoes than in the lower flowers at the commercial tomato fields. The opposite was true for immatures, with more being collected from the lower flowers. Reitz (2002) reported similar results for *F. bispinosa* (Morgan). Increased activity of thrips within the higher canopy of plants was also reported by Broadsgaard (1989) and Gillespie and Vernon (1990). The results of the present study indicated that the higher percentage of adult thrips was found in the upper canopy in the control orchard compared to the commercial orchard (Table 2). This result could be explained as adults near the top were more susceptible to frequent insecticides application than those located in the lower canopy.

Effects of Temperature and Relative Humidity on the Population of Thrips

A linear regression analysis resulted in a positive slope showing a positive relationship between the mean number of both thrips species per panicle and temperature in both orchards (*T. hawaiiensis*; commercial: F=11.13, df=1,9; P=0.009, y=4.74x-114.72 and control: F=7.09, df=1,8, P=0.02, y=5.74x-141.38 and *S. dorsalis*; commercial: F=6.50, df=1, 9, P=0.03, y=1.93x-40.99 and control: F=3.92, df=1,8, P=0.03, y=3.20x-56.74). The density of thrips appeared to increase within the mango panicles with increased temperature, but the population densities of *Thrips hawaiiensis* (commercial: F=6.24, df=1,9, P=0.03, y=-0.75x+92.38 and control: F=2.68, df=1,8, P=0.03, y=-0.76x+102.39) and *S. dorsalis* (commercial: F=1.04, df=1,9, P=0.04, y=-0.18x+32.93 and control: F= 1.03, df=1,8, P=0.04, y=-0.07x+40.22) were negatively associated with relative humidity, which is in agreement to Bagle (1993) and Wahla *et al.* (1996) who reported that relative humidity had a negative relationship with the thrips population.

CONCLUSIONS

Identifying the species composition of thrips inhabiting within mango panicles and determining the temporal pattern of thrips population during flower development will lead to improve sampling protocols and management plans for flower thrips. Large populations of *T. hawaiiensis* and *S. dorsalis* within mango panicles in both orchards have provided evidence that these two thrips species were responsible for cosmetic injuries observed on the mango fruits at these orchards.

In particular, more adults (of both species) were found in flowers on the upper canopy, while more immatures were collected from the lower canopy. This information is important for selecting the most appropriate sampling unit to estimate the densities of the adult and immature and for effective insecticides application. Three major population peaks were observed for the two thrips species in one season at both the orchards. Determining the peak of thrips abundance within the mango panicles ensures effective timing for sampling and controlling this particular pest at mango orchards.

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