STUDY ON MORPHOLOGY, BIOLOGY OF *Thrips palmi* AND EFFICIENCY OF DIFFERENT CONCENTRATION OF NEEM LEAF EXTRACT ON DRAGON FRUIT

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Abstract

A study on morphology and biology of *Thrips palmi* and effect of some insecticides and neem leaf extract on dragon fruit was conducted at Southern Horticultural Research Institute (SOFRI) and the dragon fruit farms at Duong Xuan Hoi village, Chau Thanh district, Long An province from April 2016 to December 2017. The results showed that the adult of *Thrips palmi* was light yellow, antennae of male had seven segments and eggs were milky white in color. The life cycle of *Thrips palmi* completed in 14 - 22 days. The lab trial to study efficiency of nine concentrations of neem leaf extract was conducted at Plant Protection Division-SOFRI; the results showed that two treatments of neem leaf extract were highly effective against *Thrips palmi* with a concentration of 8% (80.83%) and 9% (84.64%) at 7 days after spraying in lab conditions. The results on field trial indicated that neem leaf extract at 8% concentration was 77.91% efficient, which was as effective as Spinetoram, Imidacloprid, and Azadirachtin + Emamectin to control *Thrips palmi* at field condition. The rate of "ring net" phenomenon of four treatments: Spinetoram, Imidacloprid, Azadirachtin + Emamectin, and Azadirachta indica-neem leaf extract (12.75 - 17.43%) were low and significantly different compared with the control (42.12%).

Keywords: Dragon fruit, neem leaf extract, "ring net" phenomenon, soft insecticides, *Thrips palmi*

INTRODUCTION

Currently, the area of dragon fruit in Vietnam is estimated for 45,449 hectares and is commonly grown in Binh Thuan, Long An and Tien Giang provinces with productivity of 487,968 tons (MARD - Vietnam, 2017). It is considered a fruit that helps Vietnamese growers escape poverty. About 80% of dragon fruit production in Vietnam exports to 40 countries and regions in the world, including the high quality requirement markets such as USA, Europe, and Japan. As the demand for dragon fruit is expanding, the growers are not able to manage dragon fruit orchards properly, leading to some new emergence of pests and diseases, causing major damage to production, and threatening the export of dragon fruit in the future. Behind canker disease, which seriously damages dragon fruit production, thrips also contribute damage on this crop. They attack flowers and young fruits. At thrips infested sites, the symptoms on fruit are scab-like, rough skin which is called "ring net" or "da banh" phenomenon. The flowers could drop-down if there is a high population of thrips. Thrips do not significantly affect yields, but greatly affect the exportation capacity, which reduces the commercial value of the fruit (Martin and Mau, 1992). Huynh Thanh Loc (2016) reported that collecting of dragon fruit flowers with 85 samples in Tien Giang and 35 samples in Long An showed that two species of thrips were found on dragon fruit flowers, namely *Thrips palmi* Karny and *Scirtothrips dorsalis* Hood. The major damage to dragon fruit flower was *Thrips palmi* Karny with 88.24% and 85.71% in Tien Giang and Long An, respectively. Thrips have many host plants and high pesticide resistance capacity, so control of the pest is very difficult (Hamid-Reza, 2009). Besides that, insecticide residues in agricultural products, especially fresh vegetables and fruits, increase the risk of cancer in consumers and producers (Fitriasari and Prijono 2009). As a result, it is necessary to find a safe and effective method to control the pest. Some plants contain many compounds, which have insecticidal, antifeedant, and growth inhibitor effect on this pest. Many compounds have no toxic effect or a low toxicity to non-target pests and humans, and are environmentally-friendly (Wei *et al.,* 2011). Today, neem products are also used selectively in controlling pests of various economically useful plants. The seeds contain a complex secondary metabolite azadirachtin which acts as an anti-feedant and repellent to protect the crop from insects.

Although *Thrips palmi* is common on other crops, thrips has just occurred on dragon fruit in the South of Vietnam. The study on this pest on dragon fruit has not yet been conducted. The growers at focus dragon fruit areas do not know the timing of peak thrips population, or which methods to use to control them. Thus, study on morphological and biological characteristics of Melon thrips and efficacy of some botanical and soft insecticides to control the thrips on dragon fruit was performed.

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MATERIALS AND METHODS

Materials

Melon thrips, red flesh dragon fruit variety orchard, dragon fruit flowers; Magnifier, Olympus fluorescence microscope, Soxhlet distillation, sprayer; Soft brush, vial, blotting-paper, plastic bag, petri dish, slide, lame, scissors, cage netting (180 × 130 × 100 cm); Alcohol 98%, HCl 10%, NaCl, KOH, Chloral hydrate, Gum Arabic, NaOCl, glycerin, metanol, distilled water, Hoyer media; Soft insecticides and neem extract: Spinetoram (Spinetoram 60EC), Imidacloprid (Imidacloprid 050SC), Azadirachtin+ Emamectin (Promathion 55EC), *Azadirachta indica*-neem leaf extract, and *Allium sativum*-commercial garlic powder product.

Methods

Study on morphology and biology of Thrips palmi on dragon fruit

For biology observation, one male and one female adult were put into a box (13 × 9 cm) with some flower petals, adding honey as food for the thrips. Daily observation of the petals to find new eggs took place every 12 hours. A small needle was used to separate the petal containing the eggs and each egg was placed into a small petri dish with the new petal base on absorbent paper. The petals were replaced when needed. Each stage of the thrips was observed at least 30 individuals every 8 hours and specific time of change stages of the thrips, following method of Ha Quang Hung (2005) with modifications. Duration of developmental stages of eggs, larvae, pre-pupae, pupae and the time of the first egg occurrence, and life cycle of the thrips were recorded. The thrips were reared at room conditions at 28 ± 1°C and 65 ± 5% RH.

For morphological observation, the larvae, pupae, and adults were fixed in Hoyer media following the methods of Krantz (1975). These specimens were observed using a 40-100X magnifier, following taxonomic system of Mound and Azidah (2009) and Chin (2016).

Efficiency of some soft insecticides and plant extracts against Thrips palmi on dragon fruit

Preparing neem leaf extract: Neem leaves were extracted using a Soxhlet distillation (Behr Labor Technik-R 106S), according to Dodia *et al.* (2008).

Laboratory trial: Dragon fruit flower petal of 20 cm diameter was cut, dipped in various concentrations of neem leaf extract, and kept above moistened cotton in petri dish. Twenty individuals of larvae *Thrips palmi* were released onto the flower petal. All petri dishes were kept at 28 ± 1°C and 65 ± 5% RH in lab conditions. The trial was arranged in a randomized complete design consisting of ten treatments (nine treatments at nine concentrations of neem leaf extract at 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, and control treatment which was sprayed with water, respectively) with three replications for each treatment with a petri dish per replication. Number of living individuals in each treatment after 1, 3, 5, and 7 days after spray were recorded. The efficiency (H%) of neem leaf extract at different concentrations was calculated according to Abbott formula.

Field trial: The experiment was performed at the dragon fruit orchard at Duong Xuan Hoi village, Chau Thanh, Long An to evaluate the efficacy of some soft insecticides and neem leaf extract and which concentration showed high effectiveness to control the thrips in lab conditions. The treatment was arranged in a randomized complete blocks design consisting of six treatments (T1-Spinetoram (15 mL/16L), T2-Imidacloprid (10 mL/16L), T3-Azadirachtin + Emamectin (50 mL/16L); T4-*Azadirachta indica*-neem leaf extract (8%), T5-*Allium sativum* (1%), and T6-control-water) with eight replications per treatment with a dragon fruit tree containing more than 20 flower buds 10 days of age per replication. Soft insecticides and neem leaf extract were applied by a motor sprayer. The volume of applied mixture was 100 liters per ha. The number of living individuals was recorded before spray, 3, 7, and 10 days after spray. Besides that, the rate of "ring net" phenomenon on the fruits was recorded at harvest time, following formula: Percentage of infected fruit (%) = (Total infected fruits/Total observed fruits) × 100. The efficiency of the soft insecticides and neem leaf extract was estimated by Henderson Tilton formula (1955).

Data analysis

The morphology and biology data was carried out using Microsoft Excel software. The data of the trials in lab and field conditions was analyzed using the analysis of variance (ANOVA) and the mean values were compared by using the Duncan using statistical package for the social sciences (SPSS) 16.0 version.

Time and place of the study

Time: From April 2016 to December 2017.

Place: A study on morphology and biology of *Thrips palmi* and effect of some insecticides and neem leaf extract on dragon fruit was conducted at Southern Horticultural Research Institute (SOFRI) and the dragon fruit farms at Duong Xuan Hoi village, Chau Thanh district, Long An province.

RESULTS AND DISCUSSION

Morphology and biology of Melon thrips (*Thrips palmi*) on dragon fruit

Morphological characteristics: The eggs were deposited individually in the host tissue underneath the epidermal layer slightly overhanging. The eggs were often laid on flower or young fruit especially near tail of fruit. The eggs were white in color then later turned to milky white, 0.16 - 0.20 mm in length, and kidney shaped. The first instar larvae were milky white then turned yellowish, 0.34 ± 0.03 mm in length, 0.15 ± 0.01 mm in width, did not divide thorax and abdomen, and had red compound eyes. The second of larval stage was yellow in color, 0.62 ± 0.08 mm in length, 0.18 ± 0.02 mm in width. The immature stages were wingless. The pupal stage was divided into two periods: pre-pupa and pupa. The pre-pupa stage was 0.77 ± 0.11 mm in length, 0.23 ± 0.04 mm in width, had wing up to the third abdomen segment, antenna forward. The pupa was 0.88 ± 0.10 mm in length, 0.27 ± 0.03 mm in width, had a long wing up to the fourth abdomen segment, and antennae tilted rearwards to get close to the body. The adult was small, light yellow in color, 0.98 ± 0.20 mm in length, 0.29 ± 0.06 mm in width, antenna had seven segments with the 3rd and 4th segments of antennae had sensory organs that were cone-shaped and divided into two branches. The wings were long, transparent, with fringe of setae around the outside edge of wings.

Biological characteristics: A female laid an average of 42 ± 4.78 eggs when mating a male and a female. The eggs lasted 3 - 5 days. The first instar larvae were active and its last 2 - 3 days duration. The second instar took 3 - 4 days, average of 3.47 ± 0.51 days. Its sucking capacity was better than the first instar, and it moved slower when moulting into the pupal stage. The pre-pupal stage was 2 - 3 days, while the duration of pupa lasted 2 - 4 days. The life cycle of the thrips on dragon fruit was an average of 17.41 days at 28 ± 1^{o}C and 65 ± 5% RH (Table 1). The stage of egg to adult was found on flower or young fruit, but pupal stage was found on the soil around the stump. The thrips adult moved quickly on the surface of flower buds, young fruits, particularly near fruit tails. Fruit damage is caused by feeding and oviposition. Both larvae and adults sucked in the resin. Feeding damage was found in slightly raised areas around fruit tail that were grayish brown to grayish silver at first developing brown scab. The damage area could extend to cover most tails of infected fruit. The symptom on fruit was scab-like. When the fruit was over 7 days of age the thrips were not able to damage the fruit. The damage had affected economic value of the fruit.

Table 1. Developmental stages of *Thrips palmi* on dragon fruit

Developmental stages	Time (days)	
	Fluctuation	***Average ± SD***
Egg	3 – 5	3.77 ± 0.82
First larva instar	2 – 3	2.53 ± 0.51
Second larva instar	3 – 4	3.47 ± 0.51
Pre-pupa	2 – 3	2.47 ± 0.51
Pupa	2 – 4	2.80 ± 0.76
Adult	2 – 3	2.37 ± 0.49
Life cycle	14 – 22	17.41 ± 3.52

Notes: Average: Means of 30 individuals was observed.

In this study, the results of morphology and biology of *Thrips palmi* on dragon fruit flowers at room temperature of 28 ± 1^{o}C, RH 65 ± 5% showed that the thrips caused "ring net" phenomenon on dragon fruit. The life cycle was 14 - 22 days. This result was similar to some studies on biological characteristics of *Thrips palmi*, the life cycle lasted 17.5 days at 25^{o}C (Wang *et al.,* 1986); 26 days at 17^{o}C (Martin and Mau, 1992).

In dragon fruit crop, the eggs of *T. palmi* hatched after 3.77 ± 0.82 days, similar to other results, 3 days (Martin and Mau, 1992) and 3.79 days (Hoang Anh Tuan, 2002).

Efficiency of some soft insecticides and neem leaf extract against *Thrips palmi* on dragon fruit

Laboratory trial: The results of the trial showed that efficiency of all treatments of different concentrations of neem leaf extract against the thrips were significantly different in comparison with control at 1 day after spray, but among different concentration treatments were not significantly different. At 3 days after spray, the treatment of 8% neem concentration was highly effective (43.57%) against *T. palmi*, and differed significantly in comparison with the treatments of 1%, 2% concentration and control. The treatments of concentrations from 4% to 9% were highly effective in controlling *T. palmi* compared with concentrations from 1% to 3% and control at 5 days after spray. Two treatments were highly effective, 8% (80.83%) and 9% (84.64%) concentrations compared to other treatments in controlling the thrips at 7 days after spray at lab conditions (Table 2).

Table 2. The efficiency of neem leaf extract of *Thrips palmi* at nine concentrations

Treatment	Efficiency (%)			
	1 DAS	***3 DAS***	***5 DAS***	***7 DAS***
Neem leaf extract 1%	7.12^{a}	18.13^{c}	29.7^{b}	44.34^{c}
Neem leaf extract 2%	10.63^{a}	21.74^{bc}	38.97^{b}	44.23^{c}
Neem leaf extract 3%	10.72^{a}	23.78^{abc}	42.58^{b}	50.00^{c}
Neem leaf extract 4%	12.38^{a}	27.39^{abc}	57.52^{a}	67.32^{b}
Neem leaf extract 5%	15.99^{a}	36.45^{abc}	64.73^{a}	73.09^{ab}
Neem leaf extract 6%	12.38^{a}	32.65^{abc}	63.10^{a}	78.87^{ab}
Neem leaf extract 7%	14.13^{a}	34.21^{abc}	64.43^{a}	76.80^{ab}
Neem leaf extract 8%	14.23^{a}	43.57^{a}	70.41^{a}	80.83^{a}
Neem leaf extract 9%	14.23^{a}	41.62^{ab}	70.20^{a}	84.64^{a}
Control	0^{b}	0^{d}	0^{d}	0^{d}
CV (%)	*28.21*	*15.99*	*7.79*	*7.07*

Notes: DAS: day after spray. The data was converted to arcsin (x + 0.5)½ before statistical analysis. The value means within a column marked by the same letter were not significantly different at 99%.

The current insecticides have mainly caused resistance in outbreaks of Melon thrips on many crops, which showed that chemical treatments were not effective in controlling thrips (Morse and Hoddle, 2006). The effect of ethanolic *Azadirachta indica* and *Allium sativum* extracts on *T. palmi* showed that the mortality percentage of the thrips (1 - 2 days old) after 72 h was more than 66% (Najmizadeh *et al.,* 2012).

Field trial: The results of the trial showed that efficiency of all treatments against the thrips were significantly different in comparison with control at 3 and 7 days after spray, but were not significantly different together against the thrips. At 10 days after spray, Spinetoram treatment was highly effective (89.14%), next to Imidacloprid (75.72%), *Azadirachta indica*-neem leaf extract (77.91%), and Azadirachtin + Emamectin (74.57%) differed significantly in controlling the thrips compared with other treatments. The treatment of *Allium sativum*-commercial garlic powder (52.66%) had lower effectiveness than other treatments in controlling the thrips at field condition (Table 3).

The result of the field trial indicated that neem leaf extract at 8% concentration was 77.91% efficient, which was as effective as Spinetoram, Imidacloprid, and Azadirachtin + Emamectin to control *T. palmi* at field condition. Arutselvi (2012) recorded that neem leaf extract at 20% concentration was 77.67% effective in controlling *Panchaetothrips indicus* in *Curcuma longa* leaves. Boricha (2010) reported that combining chemical insecticides and bio-insecticides controlled *Thrips tabaci* attacking cotton. Besides that, Cermeli (1993) reported that 11 insecticides were tested to against thrips on soybeans, the results showed that Flufiloxuron, Imidaclopid, Chlofluazuron and Oxamy were most effective, but no insecticide was effective over 80%.

Table 3. The efficiency of some soft insecticides and neem leaf extract against *T. palmi* on dragon fruit in field condition

Treatment	Efficiency (%)		
	3 DAS	***7 DAS***	***10 DAS***
Spinetoram	61.84^{b}	76.47^{b}	89.14^{a}
Imidacloprid	53.32^{b}	65.22^{b}	75.72^{ab}
Azadirachtin+ Emamectin	57.18^{b}	59.40^{b}	74.57^{ab}
Azadirachta indica-neem leaf extract	54.61^{b}	63.12^{b}	77.91^{ab}
Allium sativum-commercial garlic powder	47.12^{b}	51.24^{b}	52.66^{b}
Control	0^{a}	0^{a}	0^{c}
CV (%)	*41.13*	*39.32*	*34.97*

Notes: DAS: day after spray. The data was converted to arcsin (x + 0.5)½ before statistical analysis. The value means within a column marked by the same letter were not significantly different at 99%.

The impact of soft insecticides and neem leaf extract against the thrips to rate of "ring net" phenomenon: The results claimed that the rate of "ring net"

phenomenon infected fruit at harvest time was highest in the control (42.12%), following the treatments of *Allium sativum*-commercial garlic powder with a rate of 23.14%. In contrast, the rate of "ring net" phenomenon of four treatments, Spinetoram; Imidacloprid; Azadirachtin + Emamectin; and *Azadirachta indica*-neem leaf extract, were 12.75 - 17.43% lower significantly different in comparison with the control (Table 4).

The data was converted to arcsin (x + 0.5)½ before statistical analysis. The value means within a column marked by the same letter were not significantly different at 99%.

Table 4. The rate of "ring net" phenomenon infected fruit by *Thrips palmi* at harvest time

Treatment	The rate of "ring net" phenomenon (%)
Spinetoram	12.75^{b}
Imidacloprid	13.54^{b}
Azadirachtin+Emamectin	17.43^{b}
Azadirachta indica-neem leaf extract	16.12^{b}
Allium sativum	23.14^{ab}
Control	42.12^{a}
CV (%)	*37.32*

Figure 1. (A) Adult, (B) Antenna of *Thrips palmi*, and (C) Symptom of mature fruit

CONCLUSIONS AND RECOMMENDATIONS

In this study, the results of morphology and biology of *Thrips palmi* on dragon fruit flowers at room temperature of 28 ± 1°C, RH 65 ± 5% showed that the eggs were white in color, and then turned to milky white, 0.16 - 0.20 mm in length, and kidney shaped. The first instar larvae were milky white, then turned yellowish, 0.34 ± 0.03 mm in length. The second of larval stage was yellow in color, 0.62 ± 0.08 mm in length. The pupa was 0.88 ± 0.10 mm in length. The adult was small, light yellow in color, 0.98 ± 0.20 mm in length. The wings were long, transparent, with fringe of setae around the outside edge of wings. A female laid an average of 42 ± 4.78 eggs when mating a male and a female. The eggs lasted 3 - 5 days, the first instar larvae were active and its last 2 - 3 days duration, the second instar took 3 - 4 days, the duration of pupa lasted 2 - 4 days, and the life cycle of the thrips on dragon fruit was an average of 17.41 days. The thrips caused "ring net" phenomenon on dragon fruit. The life cycle was 14 - 22 days.

The results of the lab trial showed that efficiency of different concentrations of neem leaf extract against the thrips were significantly different. Two treatments were highly effective, 8% (80.83%) and 9% (84.64%) concentrations compared to other treatments in controlling the thrips at 7 days after spray.

The result of the field trial indicated that neem leaf extract at 8% concentration was 77.91% efficient, which was as effective as Spinetoram, Imidacloprid, and Azadirachtin + Emamectin to control *T. palmi* at field condition.

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SUSTAINABLE RICE STRAW MANAGEMENT IN VIETNAM: CURRENT SITUATION, CHALLENGES AND POTENTIAL

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Abstract

Vietnam is now one of the world's largest rice-producer all over the world. The development of intensified production systems and high-yielding mordern rice varieties has increased the amount of rice straw for the last three decades. In this paper, the quantity of rice straw in different agro-ecological zone of Vietnam were estimated based on statistical data of rice productivity and ratio value of dry rice straw with rice grain. The use and potential of rice straw were evaluated by reviewing existing articles from scientific journals and reports. The results showed that Vietnam produce annually more than 51 million tons of dry rice straw so that rice straw management is an opportunity

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