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Effectiveness of Biopesticide against Insects Pest and Its Quality of Pomelo (*Citrus maxima* Merr.)

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***Abstract*—**Effect of biopesticide from wood vinegar and extracted substances from 3 medicinal plants such as: non taai yak (*Stemona tuberosa* Lour), boraphet (*Tinospora crispa* Mier) and derris (*Derris elliptica* Roxb) were tested on the age five years of pomelo. The selected pomelo was carried out for insects' pest control and its quality. The experimental site was located at farmer's orchard in Phichit Province, Thailand. This study was undertaken during the drought season (December to March). The extracted from plants and wood vinegar were evaluated in 6 treatments: 1) water as control; 2) wood vinegar; 3) *S. tuberosa* Lour; 4) *T. crispa* Mier; 5) *D. elliptica* Roxb; 6) mixed (wood vinegar + *S. tuberosa* Lour + *T. crispa* Mier + *D. elliptica* Roxb). The experiment was RCB with 6 treatments and 3 replications per treatment. The results showed that *T. crispa* Mier was the highest effectiveness for reduction population of thrips (*Scirtothrips dorsalis* Hood) and citrus leaf miner (*Phyllocnistis citrella* Stainton) at 14.10 and 15.37 respectively, followed by treatment of mixed, *D. elliptica* Roxb, *S. tuberosa* Lour and wood vinegar with significance different. Additionally, *T. crispa* Mier promoted the high quality of harvested pomelo in term of thickness of skin at 12.45 mm and *S. tuberosa* Lour gave the high quality of the pomelo in term of firmness (276.5 kg/cm$^{2)}$ and brix (11.0%).

***Keywords*—**Wood vinegar, Medicinal plants, Pomelo (*Citrus maxima* Merr.), Thrips (*Scirtothrips dorsalis* Hood), Citrus leaf miner (*Phyllocnistis citrella* Stainton).

I. Introduction

POMELO [*Citrus maxima* (Burm.) Merr. or *Citrus grandis* (L.) Osbeck)] is one of the tropical fruit which native to Southeast Asia [1]. It is a large citrus fruit with a common name of pomelo or shaddock that belongs to the family of *Rutaceae* [1], [2]. There are many popular varieties of pomelo in Thailand which known as Khaw Phuang, Khaw Thongdee and Khaw Numpung. The pomelo "Tha Khoi" variety is very famous and widely grown in Phitchit Province, Thailand. It was promoted to commercial product for domestic and export. Planting area of pomelo "Tha Khoi" variety is in Phitchit Province. The important problem of pomelo cultivation in this area is yield and quality. These caused by outbreaks of insect pests lead to farmers used much more chemical pesticides [3]. Those affected to farmers health and the environment. Therefore, using of fermented organic from herbs and wood vinegar to repelling the insects pest such as neem seed, turmeric, tobacco, derris, etc. [4], [5]. Also biological control is one of the best options for controlling this pest in citrus orchards [6]. In Thailand, *Phyllocnistis citrella* Stainton and *Scirtothrips dorsalis* Hood have been a major problem to citrus production in the past 40 years [7].

The citrus leafminer *Phyllocnistis citrella* Stainton, (Lepidoptera: *Gracillariidae*) is a potentially serious pest of citrus and related Rutaceae, and top grafted trees in citrus-producing areas of the World. It has been a widely distributed pest in citrus-growing regions of Asia for many years. In the last two decades, leafminers have invaded most of the citrus-producing regions of the world [8].

The thrips *Scirtothrips dorsalis* Hood, (Thysanoptera: *Thripidae*) is widely distributed along its native range in Asia including Malaysia, Myanmar, Pakistan, Philippines, Taiwan, and Thailand. In Thailand the hosts of *S. dorsalis* is abundant on sacred lotus [9]. In South America, *S. dorsalis* has been found causing serious damage to grapevine in western Venezuela [9], [10].

Wood vinegar has been used for a variety of purposes, such as industrial, livestock, household and agriculture products. Wood vinegar improves soil quality, eliminates pests, plant growth regulator or plant growth inhibitor [4], [11].

Stemona tuberosa Lour known as "Non taai yak" in Thai belongs to family *Stemonaceae*. It has been used as a traditional Thai medicine with a wide range of applications liver cancer, skin infections, anti-parasitic agent, etc. [12]. The extracted from tuberous roots of *S. tuberosa* was used for antifeeding on larva of *Plutella xylostela* L. and *Spodoptera litura* F. [13].

Tinospora crispa Mier known as "Boraphet" in Thai belongs to family *Menispermaceae* which is an indigenous climber plant that commonly grows wild in to the tropical areas of India, Myanmar and Sri Lanka including Thailand. [12].

Derris (*Derris elliptica* (Roxb.) belongs to family *Fabaceae* and it is a tuber crop which grows well in tropical and sub-tropical regions [12]. It is well-known as a rich source of rotenoids. The plants have been used by native fishermen in many tropical countries as fish poisons to stupefy fish prior to capture and the ground root preparations were used as insecticides [14].

The aim of this study is to investigate effectiveness from biopesicide from wood vinegar and organic substances from plants to control the insects' pest of pomelo which lead to good quality for domestic market and export.

II. Materials and Methods

A. Crop and Experiment Establishment

The experiment was conducted at Farmer's orchard in

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Phichit Province, Thailand in the drought season between December-March. Five years old of the variety "Tha Khoi" of pomelos were selected for this study with 15 trees per rows from all of 10 rows of the pomelo orchard. The pomelo was treated with 6 treatments of biopesticides from wood vinegar and fermented organic substances from plants. Each plants substances was fermented in molasses at 50 ml/25 liters of water included with 12 gm of a microbial activator. Beginning at 1 month after pruning the pomelo, the 6 treatments were applied as foliage application at 7 days intervals a total of 15 times intervals. All of the treatments were diluted with water in a 1:200 ratio prior to spraying.

B. Experimental Design

The experiment was Randomized Complete Block (RCB) with six treatments and three replications as follows:

1. Water (control)
2. Wood vinegar
3. *Stemona tuberosa* Lour
4. *Tinospora crispa* Mier
5. *Derris elliptica* Roxb
6. Mixed (wood vinegar + *S. tuberosa* Lour + *T. crispa* Mier.+ *D. elliptica* Roxb

C. Data Collection

The data was collected from amount of insect pest population of pomelo found in the treated area. The major pests of pomelo as: thrips (*Scirtothrips dorsalis* Hood) and citrus leafminer (*Phyllocnistis citrella* Stainton) were collected and recorded very week after application the treatments. The harvested pomelo was measured the quality with physical and chemical properties in term of thickness of skin, firmness and brix by Penetrometer and Refractometer.

D. Statistical Analysis

The significance of treatments was calculated by one way Analysis of Variance (ANOVA) and effective treatment was separated by the Duncan new multiple ranges test (DMRT). Differences between means were considered significant at $P< 0.05$.

III. Result

A. Effect of Wood Vinegar and Organic Substances from Plants on Pomelo Insects Pests

Table I showed mean numbers of *Phyllocnistis citrella* Stainton population from the 1st week through the 15th week in response to the application of the treatment of biopesticide (wood vinegar and organic substances from plants) were significantly different. The mean numbers of *P. citrella* Stainton population found on pomelo at the 1st week after application the 6 treatments resulted 23.50, 19.70, 17.00, 23.35, and 26.85 with application of wood vinegar, *S. tuberosa* Lour; *T. crispa* Mier; *D. elliptica* Roxb and mixed respectively compared with the number of *P. citrella* Stainton up to 83.00 by treatment of control (water). The 4th treatment (*T. crispa* Mier) showed the highest effectiveness on reduction of *Phyllocnistis citrella* Stainton with the mean population only 17.00 (Table I).

Table II showed mean of abundance of *Scirtothrips dorsalis* Hood from the 1st week through the 15th week in response to the application of the 6 treatment. Similarly, the treatment of *T. crispa* Mier showed the highest effectiveness on control the population of *S. dorsalis* Hood. The mean abundance of this insect pest found on pomelo only 8.35, 13.00, 6.50, 9.70, 10.20 and 12.00 that found from the 1st week to the 7th week. But after the 10st week until the 15st week the high number of *S. dorsalis* Hood had found up to 23.30 and 24.00. However, it had significantly different when compared to control (Table II). In additional, the average lowest population of *S. dorsalis* (6.5) and the highest population of *S. dorsalis* (24.0) were found in the 3rd week and the 15th week after treatment respectively. The average lowest number of *P. citrella* (6.80) and the highest number of *P. citrella* (26.15) were found in the 5th week and the 15th week after treatment respectively. Meantime the other treatments: wood vinegar, *S. tuberosa* Lour, *D. elliptica* Roxb and mixed were applied on pomelo. The result revealed population of *S. dorsalis* and *P. citrella* were found in the range of 17.00 to 43.50. Particularly, the highest of *S. dorsalis* and *P. citrella* are infested on pomelo when applied with control (water) in the range of 71.50 to 91.00.

Therefore, the average of population of *P. citrella* found on pomelo after application with treatment of various biopesticide with wood vinegar, *S. tuberosa*; *T. crispa*; *D. elliptica* and mixed were 27.79, 25.03, 15.37, 26.69 and 22.85 respectively. But the control treatment found *P.citrella* up to 78.01. Meantime the average of population of *S. dorsalis* found with treated pomelo of wood vinegar, *S. tuberosa*; *T. crispa*; *D. elliptica* and mixed were 26.99, 27.71, 14.01, 24.96 and 23.71 respectively and high number of *S. dorsalis* found on control treatment up to 78.99 as shown on Fig. 1.

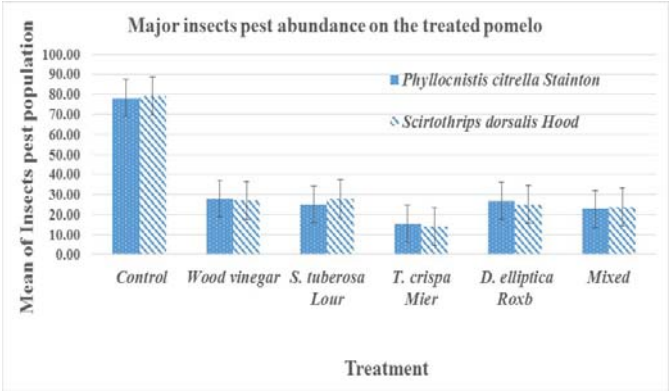

Fig. 1 Average of major insects pest population on the treated pomelo through the experiment: *Scirtothrips dorsalis* Hood and *Phyllocnistis citrella* Stainton

TABLE I
MEAN NUMBERS OF *PHYLLOCNISTIS CITRELLA* STAINTON ON POMELO AFTER THE APPLICATION OF TREATMENT

Treatment	Time after treatment (weeks)							
	1	2	3	4	5	7	10	15
Control	83.00[a]	76.15[a]	78.35[a]	76.50[a]	75.50[a]	80.20[a]	73.35[a]	81.00[a]
Wood vinegar	23.50[bc]	19.65[b]	25.85[b]	31.20[b]	23.85[b]	26.15[b]	38.00[b]	34.15[bc]
Stemona tuberosa Lour	19.70[bc]	19.20[b]	22.35[b]	21.65[bc]	25.35[b]	23.00[b]	33.35[b]	35.65[bc]
Tinospora crispa Mier	17.00[c]	10.30[c]	17.20[b]	12.50[c]	9.80[c]	9.15[c]	20.85[c]	26.15[c]
Derris elliptica Roxb	23.35[bc]	20.15[b]	23.80[b]	23.85[bc]	25.00[b]	25.00[b]	28.85[bc]	43.50[b]
Mixed	26.85[b]	20.15[b]	22.00[b]	21.65[bc]	16.85[bc]	18.00[b]	30.65[b]	26.65[c]
F-test	*	*	*	*	*	*	*	*

* = significant difference, means in the followed by the same letter are not significantly different at 5% level by DMRT
Mark: Mixed= wood vinegar Stemona collinsae Craib + *Tinospora crispa* Mier.+ *Derris elliptica* Roxb

TABLE II
MEAN NUMBERS OF *SCIRTOTHRIPS DORSALIS* HOOD ON POMELO AFTER THE APPLICATION OF TREATMENT

Treatment	Time after treatment (weeks)							
	1	2	3	4	5	7	10	15
Control	79.50[a]	84.35[a]	76.30[a]	71.50[a]	81.80[a]	75.35[a]	91.00[a]	72.15[a]
Wood vinegar	17.80[bc]	23.30[bc]	22.85[b]	26.00[b]	26.50[b]	27.00[b]	37.85[b]	34.65[b]
Stemona tuberosa Lour	25.85[b]	20.35[bc]	21.35[b]	22.80[b]	27.00[b]	29.65[b]	39.50[b]	35.15[b]
Tinospora crispa Mier	8.35[c]	13.00[c]	6.500[c]	9.70[c]	10.20[b]	12.00[c]	23.30[c]	24.00[b]
Derris elliptica Roxb	14.20[bc]	24.15[bc]	24.35[b]	21.20[b]	24.70[b]	29.15[b]	26.30[c]	35.65[b]
Mixed	21.85[b]	26.20[b]	21.85[b]	20.80[b]	22.35[b]	20.15[bc]	31.20[bc]	25.30[b]
F-test	*	*	*	*	*	*	*	*

* = significant difference, means in the followed by the same letter are not significantly different at 5% level by DMRT
Mark: Mixed= wood vinegar Stemona collinsae Craib + *Tinospora crispa* Mier.+ *Derris elliptica* Roxb

B. Effect of Wood Vinegar and Organic Substances from Plants on Physical Qualities of Pomelo:

Tables III show effect of the biopesticide on physical properties of treated pomelos after harvesting. Qualities of harvested pomelo response to the treatment of wood vinegar and organic substances from plants. This study found that *T. crispa* given the highest values of thickness of skin at 12.45 mm, meantime treatment of *S. tuberosa* showed the highest firmness and brix with 276.5 kg/cm^2, and 11.0% respectively. Although the high thickness of skin of pomelo was determined that it not good quality but the high firmness and brix are decides to be good qualities for market and export [15], [16].

TABLE III
PHYSICAL AND CHEMICAL PROPERTIES OF HARVESTED POMELO AFTER THE APPLICATION OF TREATMENT

Treatment	Thickness of skin (mm.)	Firmness (kg./cm^2)	Brix (%)
Control	13.63b	174b	9
Wood vinegar	17.50ab	150c	9.5
Stemona tuberosa Lour	19.60a	276.5ab	11
Tinospora crispa Mier	12.45b	187b	8
Derris elliptica Roxb	17.30ab	424a	8
Mixed	14.45b	203.5ab	8.5
F-test	*	*	
C.V. (%)	13.13	17.02	

* = significant difference, means in the followed by the same letter are not significantly different at 5% level by DMRT
Mark: Mixed= wood vinegar Stemona collinsae Craib + *Tinospora crispa* Mier.+ *Derris elliptica* Roxb

IV. DISCUSSION

Although there are only few studied of *T. crispa* for control insect pest, however, many previous researches reported that stem of *T. crispa* has been used by traditional folklore for various therapeutic purposes such as treatment for diabetes, hypertension, stimulation of appetite and protection from mosquito bites. Also it was also used as an anti-parasitic agent in both man and domestic animals [17], [18]. In this study, the response of pomelo to the treatment of wood vinegar and organic substances from plants was studied against *S. dorsalis* and *P. citrella.* The treatment of *T. crispa* was the highest effective control against both *S. dorsalis* and *P. citrella*. It causes a success reduction in pest populations on treated pomelo when compared to control treatment. In India, [19] reported that significant reduction in *S. dorsalis* populations by using entomopathogens *Fusarium semitectum* in pepper fields. In addition, [20] reported that the applications of oil are suitable methods to help reduction the populations of *P. citrella* in Florida. Moreover, [21] indicated that utilization of natural sources for bio-pesticides has increased. *S. collinsiae* root extracts have a great potential in agro industries and has been used as a bio-pesticide in rural areas.

According to, chemical control was annually used on this orchard by the farmer. Recently, *S. dorsalis* was reported to develop resistance against chemical pesticide such as: monocrotophos, dimethoate etc. [22]. Also *P. citrella* is controlled by growers with based on repeated application of insecticides on trees younger than five years old. Although they have effectively controlled the pest, the continued use of pesticides for several decades led to resurgence in *P. citrella* populations, and led to widespread resistance to various types of insecticides [6].

Although multiple control methods have been used in citrus orchards, only chemical control has been preferred by citrus

growers as it was easy to follow and insecticide applications yielded visible results with the reduction of all arthropods, both pest and beneficial [23]. Chemical control strategies were effective control measures in the past; however, their continued use has disrupted natural biological systems and led to dramatic resurgences in insect pest populations [24].

The biopesticide used for reduction the insects pest population, it lead to affected to quality of pomelo not only physical properties in term of size, thickness of skin and firmness but also improve chemical properties in term of pH and sweetness. Sukkarom et al. [25] reported that pomelo insect pest control with a wrap, traps and chemicals used affected to increase the quality of harvested pomelo after treated.

V. Conclusion

The demand for botanical insecticides based on natural compounds from plants methods are increasing as governments and growers world-wide become aware of the benefits, both economic and environmental, to using the biopesticide. Although the use of pesticides will still use over the next few decades, reducing the biochemical hazards they pose to health and environment. However, the application of biopesicide will continue to add to new frontiers for citrus insect pests control in Thailand. This is alternative method to environmental friendly for pomelo production.

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