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The Relationships between Thrips Populations and Climatic Factors, Mangosteen Development Stage in Nakhon Si Thammarat Province, Thailand

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Thrips population was studied from 4 mangosteen farmers'orchards in Thungsong, Cha Oad, Ronphiboon and Lanska district, Nakhon Si Thammarat province during January and December 2014. *Scirtothrips dorsalis* Hoods and *S. oligochaetus* Karny were predominantly found. Thrips abundance was peaked maximum in April at the flowering and young fruit stages, An average number of thrips/shoot was 0.10. The relationship between thrips populations and climatic factors such as temperatures, relative humidity, wind speed, rainfall and the stage of in-season and off-season mangosteen development was studied. The results of correlation coefficient value (r) at 0.30 -0.50 -0.18 -0.33 0.43 and 0.65 were illustrated, respectively which statistical significance (p) at 0.32 0.10 0.41 0.28 0.25 and 0.14 respectively, were not significantly different (p>0.05). The relationship between climate factors and a population of thrips found that relative humidity was moderate correlation (r = - 0.50) with a negative relationship and fruit development stage of the season, the relationship was moderate (r = 0.65) with a possitive relationship. For other factors, the correlation coefficient value (r) was the low level (r <0.50), and the analysis of the statistical significance value (p) found that all climatic factors were not significantly (p> 0.05) with a population of thrips.

Keywords : population, thrips, climate, correlation coefficient

Introduction

Mangosteens (*Garcinia mangostana* L.) is one of the economically important tropical fruits both for domestic consumption and exporting. It is well known in Southeast Asia and the major production comes from Thailand, Malaysia, Indonesia and the Philippines. Mangosteen fruit has a high economic value, thus it has good prospects to be developed into an excellent export commodity (Sakulrat *et. al.*, 2012). Thailand is the world's largest producer ; most production of mangosteens comes from the eastern and southern provinces. The demand for this fruit has been gradually increasing in both domestic and international markets, especially in Europe and Japan. Major problems in qualitative production are mangosteen thrips

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that destroy young leaves, flowers and young fruits, decrease the quality and cause economic losses. The damage caused by thrips were fine leaf margins roll upward bend on both sides, and brown marks leaves (Poonchaisri, 1992). If the outbreak occurs during young fruits, it may cause fruit-retarded, rough scarring on fruit surface which dislike to oversea markets. Recently, the price of mangosteens at the farmers' level has been determined based on the quality of the fruits. Those fruits which were free of scarring significantly determined the price. In Thailand, the production of high quality mangosteens is less than 60 percent of total production (DOAE, 2007). Nakhon Si Thammarat is the southern province in Thailand , on the east coast and has been the influence of wind, so there is plenty of rain. The southwest monsoon, which blows through the Indian ocean brought out water and moisture into Thailand. But the Tanaosri mountain range on the western block the airflow and the southeast province has less rain than the southern west bank, so that off-season mangosteen production can be produced in many districts.

Climate change, which is induced by global warming, has become a global concern as it may have many consequences on various systems and sectors that may threaten human wellbeing (IPCC, 2001). Climate change has a major impact on the agricultural productivity. The critical agro-meteorological variables associated with agricultural production are precipitation, air temperature and drought period. In general, tropical-fruit production is normally limited by the available soil moisture and many fruit trees, such as mangosteen , mango and litchi, require a dry period to stop vegetative growth and induce flowering. The duration of this period for mangosteen is approximately 20 day. (Sdoodee and Teake, 2007).

Many factors influence the amount of rainfall available to plants including evaporation, transpiration rates, surface runoff and soil water-holding capacity through the soil profile beyond the rooting area. Excessive rainfall also causes major problems with flowering, pests, diseases and fruit quality. Insects are the most diverse class of organisms that success and functioning evolution. Insect effects can be both positive and negative, direct and indirect, so understanding how global environmental change might influence insect effects in plant production is a challenge (Ayres and Lombardero, 2000, Fleming 2000, Harrington *et al.*, 2001, Volney and Fleming 2000). Climate change variable, mainly on temperature, rainfall, humidity and wind is most confidence in future predictions (Houghton *et. al.*, 2001) and for which evidence of effects on insects is most plentiful. The potential rate of increase of many insects is strongly dependent on temperature, and their survival is impaired at temperature extremes. The temperature changes may strongly affect the insects'physiology and spatial distribution, especially in areas where temperatures tend to be below species optimum. In these conditions, climate warming may influence insect populations by extending the growing season, altering timing of emergence, increasing growth and development rates, shortening generation times and consequently increasing the number of generations, reducing overwintering mortality and consequently increasing insect populations in the subsequent growing season, increasing the risk of invasion by migrant pests and altering their geographical distribution. Rainfall, snowfall, humidity, wind, and cloudiness are among the other climate variables expected to change, and atmospheric chemistry (e.g., CO_2, levels) will also be affected. (Harrington *et al*,. 2001; Yamamura *et al.,* 2006).

The objectives of the study were to determine the relationships between the climatic factors, mangosteen growth development stage and the thrips populations which the aim of predicting climatic trends that would cause thrips outbreaks. For farmers could integrated pest management practices strategy and climate changes information to closely monitor insect occurrence. Keeping pest and crop management records over time will allow farmers to evaluate the economics and environmental impact of pest control and determine the feasibility of using certain pest management strategies or growing particular crops.

Material and Methods

Mangosteen thrips were surveyed every week on 4 farmers' orchard in Thungsong, Ronphiboon, Lanska and Cha Oad district, Nakhon Si Thammarat province, Thailand (latitude 08°25'N and longitude 99°57'E) (wikipedia, 2015) from January to December 2014. Each district select a monoculture system production orchard, which a growing area of more than 5 rai or more and one orchard per district. The experiment was conducted using 10-15 year old mangosteen trees with spacing 8 × 8 m. Ten similar trees per orchard was selected for the experiment at the stage of young shoot, flower, young fruit, fruit development and havesting. Thrips counting and identification were randomly selected from 10 shoot per tree from around the canopy below. The method of thrips counting and identification were adapted from the way of Pankeaw (2011), which was adapted from the methods of Poonchaisri (1992). Climatic data weather data collected from 2014 to 2015 at the Nakhon Si Thammarat Meteorological Station. Regression, correlation coefficient (r) and relationships level analysis were performed to compare the relationships between thrips counts and weather variables.

The value of r is between +1 and –1. To interpret its value, correlation coefficient (r) and relationships level values , from the following :

Correlation coefficient (r)	Relationships level
0.90 - 1.00	very high
0.70 - 0.90	high
0.50 - 0.70	moderate
0.30 -0.50	low
0.00 -0.30	very low

r + = possitive correlation coefficients, *r* - = negative correlation coefficients

Resultes

Two species of thrips found on four farmers' orchards in Thungsong, Cha Oad, Ronphiboon and Lanska district, Nakhon Si Thammarat province, were *Scirtothrips dorsalis* Hoods and *Scirtothrips oligochaetus* Karny (Figure 1), Thrips abundance was peaked maximum in April at the flowering and young fruit stages, An average number of thrips/shoot was 0.10. (Table1). The relationship between thrips populations and climatic factors such as temperatures, relative humidity, wind speed, rainfall and the stage of in-season and off-season mangosteen development was also studied. The results of correlation coefficient value (r) at 0.30 -0.50 -0.18 -0.33 0.43 and 0.65 were illustrated, respectively which statistical significance (p) at 0.32 0.10 0.41 0.28 0.25 and 0.14 respectively, were not significantly different (p>0.05). (Table 2).

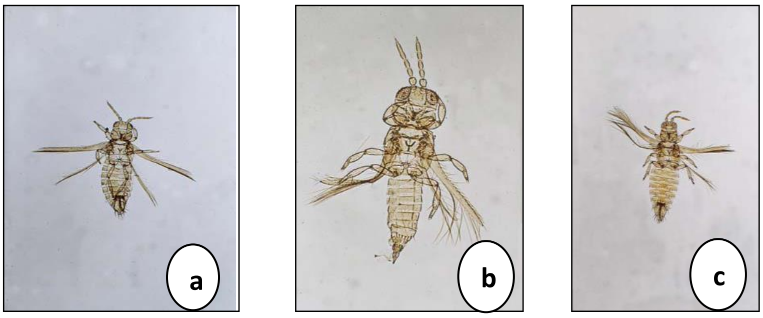

Figure 1. Mangosteen thrips, *S. dorsalis* Hoods. Female(a) Male(b) nd *S. oligochaetus* Karny female adult(c)
Source: Ngampongsai (2006)

Table 1 Average mangosteen thrips population (thrips/shoot) from four farmers' orchards and the climatic factors in Thungsong , Cha-uat, Ron Phibun and Lansaka district, Nakhon Si Thammarat province, during January to December 2014

Area / month	No. of mangosteen thrips (thrips/shoot) [1/]					Climatic factors [2/]				Mangosteen development	
	Thu.[3]	Cha.[4]	Ron.[5]	Lan.[6]	Avg.	T	RH	R	W	in-season	off-season
Jan.	0	0	0	0	0	25.35	80.32	267.5	19	Old leaves	Old leaves
Feb.	0	0	0	0	0	25.69	79.34	1.60	17	Old leaves	Old leaves
Mar.	0.03	0.06	0.08	0.07	0.06	27.21	77.72	0	21	Flower	Flower
Apr.	0.10	0.12	0.11	0.09	0.10	28.96	76.40	0.30	17	Flower/ young fruits	Flower/ young fruits
May	0.05	0	0	0	0.01	28.76	80.27	202.2	30	fruits	fruits
Jun.	0	0	0	0	0	28.72	78.03	93.70	29	fruits	fruits
Jul.	0	0	0	0	0	28.60	77.20	75.30	22	harvesting	harvesting
Aug.	0	0	0	0	0	27.80	76.35	159.1	20	Old leaves	Old leaves
Sep.	0.02	0	0	0	0.01	28.34	79.15	123.3	24	young leaves	Old leaves
Oct.	0	0 **	0**	0 **	0 **	26.85	86.98	337.6	19	Old leaves	Flower/young fruits
Nov	0	0.02	0.03	0.05	0.02	26.66	88.62	418.6	26	Old leaves	young leaves/ fruits
Dec.	0.03	0	0	0	0.01	26.41	87.08	639.2	26	young leaves	young leaves/ fruits

1/ Means from 10 shoots/tree

2/ Climatic factors : temperatures(T) , relative humidity(RH) , wind speed(W), rainfall(R)

3/ Thungsong district 4/ Ronphiboon district 5/ Lanska district 6/ Cha Oad district

Source : Nakhon Si Thammarat Meteorological Station (2015)

Table 2 Correlation coefficient (r) and statistical significance (p) between thrips populations and climatic factors : temperatures(T) , relative humidity(RH) , wind speed(W), rainfall(R) and the stage of in-season (D1)and off-season(D2) mangosteen development in Nakhon Si Thammarat province during January to December 2014

Climatic factors	Temperatures (T)	Relative humidity (RH)	Wind speed (W)	Rainfall (R)	In-season mangosteen development (D1)	Off-season mangosteen development (D2)
r [1/]	0.30	-0.50	-0.18	-0.33	0.43	0.65
p	0.32	0.10	0.41	0.28	0.25	0.14

[1/] The correlation coefficient was calculated from population converted to log 10
[2/] Statistical significance (p) at a confidence level of 95 %

The relationship between climate factors and a population of thrips found that relative humidity was moderate correlation ($r = -0.50$) with a negative relationship. Fruit development stage of the season, the relationship was moderate ($r = 0.65$) with a possitive relationship. For other weather factors, the correlation coefficient value (r) was the low level ($r < 0.50$) and the analysis of the statistical significance value (p) found that all weather factors were no significant ($p > 0.05$) with a population of thrips. (Table 2) (Figure 2)

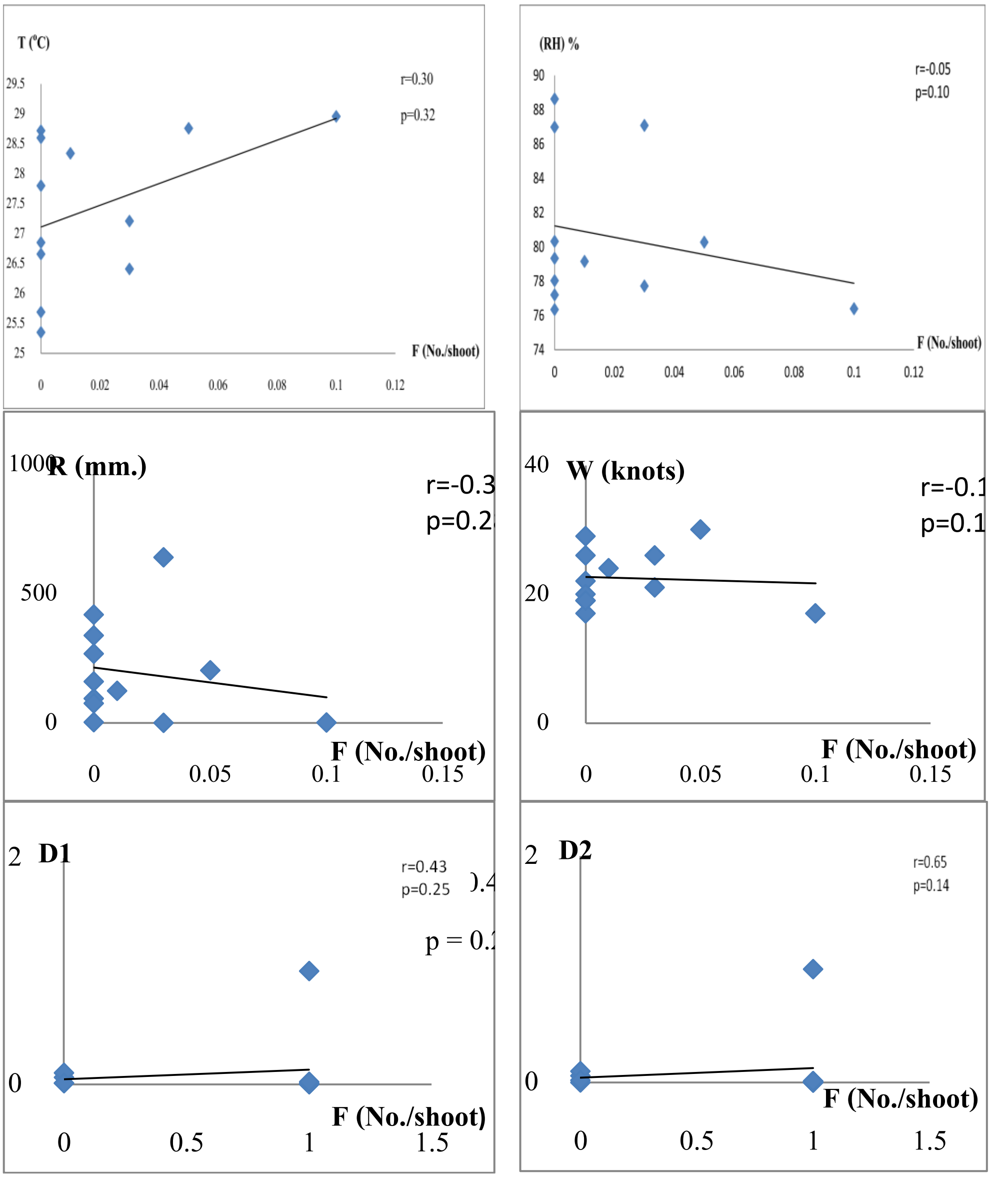

Figure 2 The correlation coefficient (r) , statistical significance (p) between thrips populations (F) and climatic factors : temperatures(T), relative humidity(RH) , wind speed(W), rainfall(R) and the stage of in-season (D1)and off-season(D2) mangosteen development in Nakhon Si Thammarat province during January to December 2014

Discussions

The simple correlation coefficient (r) analysis revealed that the relative humidity showed moderately relationships and negative effect (r = -0.50) on thrips population and the relative humidity was relation to the direction of the rainfall, These two factors greatly impact the outbreak of thrips. For these case, while rainfall, the high humidity and the temperature inside canopy will be down which these conditions are not suite for the growth of thrips and other pests. We can applicable method for controlling outbreaks of thrips by spray water from knapsack sprayer on canopy of mangosteen tree to control the humidity inside canopy, made it unsuitable for the growth of thrips and reduce popuation. The other method, to provide water at the top of canopy with four meters of water pipe, these method can reduce thrips damage well too. (Thongier, T. and Thongier, J. , 2013)

This experimental found that, the correlation analysis of temperatures with thrips population showed low relationships (r = 0.30) and positive correlation effect, that the average temperature in Nakhon Si Thammarat province is between 25-29 ^{o}C. The study of Mound (2015) reported that the optimum temperature for the development stages of various stages of avocado thrips (*S. dorsalis)* in laboratory study have indicated that as temperatures increase from 20^{o}C to 25^{o}C, population growth rates for thrips are reduced by 33%. Temperature affects on the development rate of insects and hence their population dynamics. It also influences the growth and development rate of their host plants, which may affect host availability and suitability for thrips (Davidson & Andrewartha, 1948). The highest thrips numbers were reached when temperatures were between 18^{o}C and 21^{o}C and when rainfall was low (114 to 144 mm. per month). Another study, Hamdy and Salem (1994) reported that *T. tabaci* females lay the most eggs and lived longest within temperatures of 21.1^{o}C to 23.6^{o}C and relative humidity of 52%. Temperatures above 35^{o}C and drought have been reported to be unfavorable to the survival of thrips.
(Waiganjo, *et al*, 2008)

The correlation analysis of rainfall and wind speed showed low relationships with r = -0.30 and r = -0.18, respectively and negative effect on the thrips population. Rainfall affected thrips populations both negatively and positively. It could suppress populations by killing larvae, and thrips adult populations. Rainfall suppresses thrips dispersal by suppressing flight (Lewis, 1997). However, by maintaining adequate soil moisture, rainfall can positively influence thrips populations by fostering plant growth and enhancing pupal survival. Heavy rain has been reported to wash thrips off plants down to the soil surface, causing sharp declines in their population density. (Harris *et al.*, 1936)

The effects of weather factors that influence these population changes is essential in predicting thrips population. Weather variables including rainfall, temperature, relative humidity and wind have been reported as important factors that significantly affect thrips numbers (Ananthakrishnan, 1993; Legutowska,1997). Relatively high temperatures and lack of rainfall have been associated with increase in thrips population, while high relative humidity and rainfall reduce thrips population (Hamdy and Salem, 1994). In addition to their effect on thrips activity, temperature and relative humidity further influence the intrinsic rate of natural increase of the thrips. A basic understanding of the relationship of these factors with thrips population is important in developing an integrated control strategy for thrips and in determining the potential pest control needs for a given climatic trend.

The relative humidity established significant negative correlation with thrips population increase. Rainfall emerged a poor predictor of thrips population even though it is directly related to the increase in relative humidity and has frequently been demonstrated as a decisive thrips mortality factor (Hamdy and Salem, 1994). Studies on direct evaluation of this factor in simulation models could be useful in determining its influence on thrips populations and their interactions with the mangosteen production.

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