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TRẦN VĂN NAM

TOPIC TITLE: Modeling of Insect Biodiversity and Population Dynamic on Vegetable Crops under Temperature Fluctuation

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Thai Nguyen University of Agriculture and Forestry	
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Student name	Tran Van Nam
Student ID	DTN1053180074
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Supervisor (s)	**Dr.-phil. ARINAFRIL -** Head of Pesticide Toxicology Laboratory, Lecturer at Faculty of Agriculture, University of Sriwijaya, Indralaya, South Sumatera, Indonesia **Dr. Ho Ngoc Son -** Deputy Dean of Forestry Faculty, Thai Nguyen University of Agriculture and Forestry, Thai Nguyen City, Viet Nam
Abstract: Environmental concern is a very urgent issue that needs an urgent response from the people.An experiment to determine the influence of temperature fluctuation on biodiversity of insect and its population dynamic has been carried out from September 2014 to December 2014. This experiment took places in four different farm areas in Palembang and Indralaya, both are in South Sumatra Province, Indonesia. The insects caught in each observation and in each farm were collected and identified. Models to predict the population dynamic of insects was established by putting the variable of temperature when the experiments were carried out and by making-up the temperature to assess the influence of temperature change on insect population dynamic. Results showed that the temperature could influence the existence of insects. It was indicated by the differences of the number of insects caught. Model established showed that if rise of temperature would be followed the reduction of insect.	
Keywords	Climate change Insect; Plant; Biodiversity; Population dynamic; Temperature
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PART I: INTRODUCTION

1.1 Research rationale

Nowadays, environment is a very urgent issue that needs an urgent respond from the people. Environment plays an important role not only for human beings but it also supports all of the species around the world. It is conceded as one of the most crucial issues that challenge all Environmental Scientists around the world.

Environmental change in general and climate change in particular are the most important and the most complex review that the human has to face. Effects of climate changes are the evidents in the increasing to the temperature, recurrent droughts, flooding ect. And those changes may have many serious impacts not only on the production of global crop, but also on the agriculture production and it may lead to famine and starvation. Beside that, precipitation and temperature are the climate factors which may have a very strong influence on the development, reproduction and survival of coleopteran, dipteran, flightless insects such as bugs, bees, flies, beetles, wasps such changes in climatic conditions could profoundly affect the population dynamics and the status of insect pests of the crops (Woiwod, 1997).

According to Erik E. Stange, Norwegian Institute for Nature Research, Lillehammer, Norway and Matthew P Ayres, Dartsmouth College, Hanover, New Hampshire, USA, “ The distribution and abundance of the earth’s insect species may affected by the climate powerful, warming temperature may generate changes for the population and ecosystemsof many insects and the their inhabit. Warmer or cooler

temperatures associated with climate change will tend to influence on the insect special's population dynamics directly by effecting on survival, generation time and dispersal."

Otherwise, few studies have been done on minimizing the impacts of environmental change which was invested a huge amount of money from the government. Sadly, it seems to be no change at all as it is getting to be worst. Furthermore, there are increasing numbers of bad impressions regarding environmental change.

1.2 Research's objectives

The purpose of this study is to determine how environmental change affects insect biodiversity population dynamic, or in other words, to determine all the direct and indirect impacts of climate change to the insect biodiversity population dynamic. This research is not a solution to embark upon the environmental change problem, but it could be useful to educators responsible for curriculum designing to face and tackle with in minimizing the negative effects of the environmental change. It may also lead to a better understanding for environmental change. So based on this research, some solution can be adopted to address the problem

1.3 Research Questions

The research aims to answer the following questions that we're concern about:

1. *What and how does environmental change affects the insect biodiversity population?*
2. *How is the dynamic of insects population under the changing of environment?*
3. *What are the relationship between environment and insects ?*

1.4 General Background

Each individual insect species has response to climate change. However, it will depend on their geographic range, natural history or trophic level. Insect populations are expected to benefit most from climate change through more rapid development and increased survival. There are also many effects of rising warming on tropical insect species. The warmer winter temperatures may decrease the insect species mortality, leading to pole ward range expansions. The effects of warming on insects species also can act indirectly through trophic interaction as host plants and natural enemies. The insect feature among the documented range expansions that demonstrate biological responses to the climate change. Most of the insect's species have relatively short life cycles in general, high reproductive capacity, and high mobility. The responses to warming temperatures can produce large and rapid effects on species population dynamics.

PART II: LITERATURE REVIEW

2.1 The distribution of insects

Insects are distributing everywhere in the World, it is the most abundant animal group of planet, there are including more than one million species which have been described. There are more than a half of all living organisms, and the remaining is about 6 million to 10 million species, insects can live in most of the environment or habitat, although only a few species can live in the seas or oceans where crustaceans predominate.

The distributiom of organisms can be determined by the influences to global climate change though environmental factor .It plays a very important role in defining the limitation and distribution of a species. *(Musser & Shelton 2005).*The distribution of most insect species will shift towards the poles and to higher elevations with predicted temperature increase due to climate change and temperate regions will bear the main burdenof these shifts. With changes in climate, these limits are shifting as species expand into higher latitudes and altitudes and disappear from areas that have becomeclimatically unsuitable *(Parmesan, 2006 and Menéndez, 2007).* The environment change would change the distribution of all insects, extreme weather condition have the biggest impact on species distribution, and the distribution of these insect species will be reduced in both tropical and temperate species.

2.2 Direct effects of environment change on insects herbivores

Due to the change of the environment, the number of insects have been decreasing. There included changing in rainfall pattern, and extreme climatic events, these seasonal and long term changes would affect the fauna and flora and population dynamics of insects, the abiotic parameters have direct impact on insect population dynamics through modulation, of

development rate, survival and dispersal. And in environment aspects, climate change would be the most impacts in the population dynamic of insect pest. So that is why temperature plays a very important role in insect population dynamics.

It has been studied for long time ago about the effects of the quality of host plan, predation and all factors of biotic on thepopulation of insect herbivore *(Price et al, 1980)*. The distribution and abundance of the Earth's insect species are affected by climate exerts powerful, and we should expect climate warming to generate changes for many insects populations and the ecosystems. According to a subtantial scientific literature, it provides a foundation for describing how insect species are responding to recent climate trends on the basic of insecct physiology, and the species distributions and population dynamics for the future. The warmer temperatures generally lead to more development and survival in mid – to high latitudes of insects. Due to the short life cycles, high reproductive capacity and high degree of mobility, insects physiological responses to warming temperatures can also generate particularly large and effects on species population dynamics *(Stivers 1999, et al)*.

There has been increasely studied in how climate change and other anthropogetic on natural environment affects to the interactions. In other words,it is growing interest in how such interactions may be affected in changing climate and impacts on the enviromental natural *(Bale et al 2002).* A recent attention have been the subject by the reponses of individuals, populations and simple assemblages. The effect of their associated herbivores are known unwell *(Bale et al 2002).* A group of insects herbivores are included the leaf, plant, and frog hoppers and it is being greater than other group of insects, a major inflience on auchenorrhynchan have all been shown by the effects of host

plant quality, plant architecture, plan species composition and successional age of plant community *(e.g. Waloff, 1980).*

Climate change may directly affects to the insects population dynamics, therefore, the influence of temperature on life history may maintain adaptive the time of development, and life- cycle, avoiding the low and cold temperature included mortality. Climate change on community asociates may indrectly influence to the insect population, a high degree of complexity and uncertainty can be decided to the insects responed to climate change as the number of insects can influenced directly by temperature and indrectly by climate effects on host plant and their community *(Barbara et al. 2010).*

2.3 The relationship between chaning temperature and insects

The temperature is the most important environmental factors that influence insects, including the behavior, distribution, development survival and reproduction. Climate change will result in increased temperature could impact crop pest insects population. There is not only increasing the number of insects but also decreasing the insect population depends on the natural and geographic condition.

The distribution and ecological dynamic of nuisance species are affected by climate. Therefore, it will be influenced to their economic and ecological impacts *(Dukes et al.2009)*. Increasing the metabolism, survival or reproduction rates can be affected by warmer temperatures when there is absence of water *(Dukes et al.2009).*

The effects of warmer winter or either wetter or drier summers on the dynamics of the auchenorrhynchan community at a calcareous grassland are reported. *(Safranyik et al, 1974).*Host plant physiology and others will be affected by climate change, these all may have impact on plant – insect relationships. Due to the complexity of indirect interaction

among climate, vegetation and insect herbivores, prediction is difficult but the direct effect of climate on insects may lead to phonological shifts between herbivore and host and parasitoid *(Masters et al. 1998).*

The insect consumption, development and movements can influence the population dynamics by climatic warming and it is presented via the effects on fecundity, survival, and dispersal or generation time. The impacts on the pest population also can be affected by climate change and also, climate change can affect natural enemies of insect. The changing climate by shifting the geographal distribution and population behavior can be affected to the organisms and the organisms also can quickly change in order to take the advantage of new environment. *(Thomas et al 2001).*

The forest is one of the example of long-lived ecosystem, in the forest, the insects are the first angents easy to get disturbance.*(eg, Dale et 2001, Longan et al 2003)*. To have land for cultivation, a large amount of energy are used to burn of fossil fuels and clearing of forests, and those activity can have profound effects on many fields such as agriculture, global environment and also the cost food for humans. The main driver of crop growth are solar radiation, temperature and prediction, and all of their aspects highly dependent on climate, climate may affects to crop yield potential and food production. Otherwise, climate change also affects to plant disease, pest innfestations, also the supply and demand for irrigation, and the agricultural pests. Temperature, light, and water are the main factors to control the growth and development of the spatial, temporal distribution and proliferation of insects, weeds, and pathogens. All insects strongly development in all climates, beacause their habitats and survival are strongly depend on the weather of the location, especially is in some cold-blooded insects, it is very sensitive

with temperature. It gradually affect to regional and production of global foods.*(Rosen Zweig et al. 2001)*. Climate change components may directly affects to population irruptions of insect disturbance and events a forest ecosystem function. *(Dale et al. 2001)*. The global warming are predicted to affect to the link between insect population and temperature, if atmospheric changes can influence to insect outbreaks (e.g.,Logan and Powell 2001). The forest landscape have been downloaded by climate parameters, and to manage of the future forests, should be developed and applied by predicting the insect's population success by the effects directly to temperature *(e.g., Dale et al. 2001).*

2.4 Insect population under temperature fluctuation

Mostly, when the temperature increase, it would result in increasing the number of population, Increased temperatures will accelerate the development of these types of insects. The lifecycle of insects is from 28 days to 32 days, but in fact, most of the insects die under the temperature, if the temperature is high, the insects is easly die in first two weeks. If the temperature is low, the lifecycle of insects is longer until the last lifecycle of each insects.

The result of change in the natural climate may increase by the predicting of some frequency extreme events. The status of insect pest and also the population dynamics of the crops could profoundly affected by the climate condition *(Lewis 1997)*. Some of climate change factors such as temperature rise, changes in precipitation patterns, rise of sea levels, change the duration in winter become longer or shorter, increased the extrem weather can directly affect to insects thought affecting the development of the rate, reproduction, distribution or adaptation. Otherwise, the impacts of climate also can affect indirectly to insect's host plant, natural enemies, and the interaction between insects and

the others, the change in phenology, distribution or community of ecosystem are the impact that leads to some extincetion of insect species*(Bale et al 2002).*

The number of individual insects represent the huge number of taxa,species or families of insect. With the insects have short generation times, they also have high mobility and high reproduction rates, thus, they will respond to the climate quickly than other insects. But in face, climate change may be the first indicator by insects represent. The pest under warm weather condition breeding may be the result by the change duration in winter to be shorter or longer *(Gaston & Williams 1996, Andrew & Hughes 2005)*. Some of the insect which have importance in medical, such as mosquitoes always have more impact to climate change*(Bale et al., 2002).*

Expanded pest ranges, the discruption between pets and their natural enemies can increased the outbreaks and unheavals of pests. Increasing temperaturer may change the biological of agricultural, the life cycle of insect will decresease if the global temperature increase one degree *(Bale et al., 2002).* The population of pests can increase if the life cycle of insect faster,the insects may growth faster if the temperature is warmer, if the global temperatures increase, the gegraphical ranges of the species will increase the population size *(Sutherst, 2000, Harrington et al., 2001, Bale et al., 2002 and Samways, 2005).*

Temperature increase combine with climate change may impact to pest insect population by several ways like change in geographical range into larger, change the rate of population growth, change the number of generation, change and development the season, change in crop pest, change in interaction among species, increased the invasions risk by increasing the number of pests. The effects of all temperature on insects is largely dominant than the effects of other factors of environment *(Sutherst, 2000, Harrington et*

al., 2001, Bale et al., 2002 and Samways, 2005). Increase in temperature by ~0.6ºC may have effects on ecosystem worldwide, (Walther et al., 2002) the distribution and diversity of species may largely change due to the increase of temperature. Otherwise, individual of species and communities also change in the form of range and extinction due to the global warming (*Hickling et al., 2005).*

Temperature can cause different effects due to the development strategy of insect species, the physiology and development of insects can directly or indirectly affected by the physiology and existence of hosts though the change of temperature *(Bale et al., 2002).* In order to complete one life cycle, some insects need to take several years, these insects may change to moderate temperature over their life history, some crops related to temperature so they they develop quickly during the suitable temperatures periods, if increaseing 2ºC, the insects may add more one to five life cycle per season of experience *(Yamamura and Kiritani, 1998).* Increasing 2ºC temperature, insects might experience one to five additional life cycles per season *(Yamamura & Kiritani 1998).*

Some crops being able to be grown in regions resulted by having higher averge temperature, some of the insect pests of those crop may follow the expanded crop area, with highter latitude and altitude, the isnsect species diversity tends to get decrease (Gaston & Williams 1996, Andrew & Hughes 2005) It is mean more insect species will attack more hosts if the temperature increase *(Bale et al 2002).* The diversity of insect species and the intensity of there feeding have increased by increasing the teperature *(Bale et al 2002).* Severe cold events may decrease if the warming occur, it may expand the over-wintering area for 304 insect pests *(Patterson et al.,1999).*

There will be different in changing of temperature respond between natural enemy and the population of host insects. If the population of host emerge and pass thought vulnerable life stages before parasitoids, there would be a reduced of parasitism. If the temperature is higher, hosts may pass though vulnerable life stages more quickly. Otherwise, it also may reduce the opportunity for parasitism. Some pest species can be changed in the gender of rations by temperature, the rate of reproduction also can be affected by potentially. However, if compare between the insects that spend more important parts of their life history in the soil and those that are above the soil, ground. *(Bale et al 2002).* The underground insects may be more gradually affected by the change of temperature. The reason is the soil provides an insulating medium that will tend to buffer temperature than the air. *(Bale et al 2002).*

2.5 Simile program/ Software

About the software that is using to interpret, estimate the datas. SIMILE is an intensive residential program in which students learn to approach science, technology, agriculture, and namely is environmental in there historical, cultural and social contexts. The software is not only designed for the potential scientist, engineer to understand these fields historically but also designed for humanities or social science student who want s to inderstand science, technology, cultural phenomena.

Simile is distributed and developed simulistics, modelling and simulation software for complex dynamic systems on the Earth, environmental and life science. It used unique logic-based declarative modelling technology to represent the interactions in these systems with a clearly structured, visually intuitive way. The model can be prepared more quickly, more easily and maintained more efficiently. So that is why it is considerbled to choose to analyse and interpret the data for insects population under the environment change.

PART III: METHODS

3.1 Overview of the methods.

The study has been carried out at four vegetable farms with different plants in an area of about 100 square meters per one farm. There were also include the entire insect population that was present in the area. There were also consider the temperature and the condition of the area that affects the population of the insects.

All the data that collected was based on the population of the insects and how the environmental changes affected its population dynamic. Counting the number or the population of the insects in the area every week to determine if there changed in the population of the insects that would occur based on the changes in temperature and other conditions like rainfall, humidity and other factors that affects the insect population and distribution. Separated the types of insects that needed to identify in the research area in order for us to determine the changes in population in every type of insects because not all the insects that may present in the study area had same characteristics, lifestyle or survival condition.

After collected all the data that needed in our study, all of that were used to present how does environmental change affects the insects' population dynamic. The data that were collected after collecting the data used also to determine what are types of insects would be suitable in that area with the normal area condition and what types of insects would not suitable to any change in condition or weather like change in temperature.

3.2 Popolation/ Samples and location

In order to have a sustainable sample and sustainable location to conduct the research, there must have a survey time, the location for the intership was in Palembang,

a capital city of province of South Sumatera in Indonesia. The research required at least 4 differences vegetable farms in 4 differences location. Looking for the place was in 2 days , after finding the place, It had to consider that. It would be a sustaible or not by having an interview with the owner of the farms, everything must be sure to start the research, the sustainable samples for research are the files where the farmers were growing vegetable, ensure at least one month for observation, ensure that they farmer would be not harvest or remove or destroy it , the areas of the farm was at least 10 m for the length and 10m for the width, and the most important thing was that they did not use any of chemical or pepticide, the result wouldbe far and different with what they expected, because the presence of pesticides will affect the number of insects present in the field. After 2 days of doing the survey, 4 differences vegetable farms from 4 difference locations which is the most sustainable to have the observation was decided.

First location was at Sangkuriang, Saka (Appendix 5.a) where farmers were growing Eggplant, 20 plants per 15 rows to had the observation. In this area, the surface and ground were very hard soil, the soil in cultivation rows was large arrays, non – porous, low humidity and moisture, low nutrient, the plant normarly developed and its located in the garden of household.

The second farm located at Kenten, Ashar, (Appendix 5.b) Cucumber was the plant for the observation, hard surface, porous in the soil cultivation rows, low humidity and moisture, low nutrient, close to household and it was taken 40trees per 10 rows as the sample of observation.

The third farm was at Kenten Sukamaju, (Appendix 5.c) Growers grew Green bean, the sample was very hard in the surface, the soil in cultivation rows was porous,It

very compatible with humidity moiture and nutrient.It is located in upland area, far away from household, it was 40trees per 20 rows for the area of the observation.

All of three locations located in Palembang city, it was far away about 4 kilometers with each other. So it had very far differences in geographic location, soil structure and environmental condition.

The last farm where decided to do the observation located in Indralaya Campus, 32 kilometers far away from Palembang city, (Appendix 5.d) Chili was the vegetable for the observation. The characteristic of this fields were hard soil in surface, non – porous in the soil cultivation rows involved rock and gravels, very low nutrient, and close to household, 20 trees per 10 rows were chosen to have the observation.

3.3 Materials

The research required many materials, it is included measures, technical equipments, insect identification book, images, as now will be described.

The characteristic of most insects are very small, and majority cannot be identified without the examination of minute morphological characters. Insect collecting is the collection of all the insects species and maybe for other arthropods for scientific research or study, in order to get the small insects in the fields, it is need insects net (Appendix 6.b) for flying insect and flooding square (Appendix 6.a) for soil insect.

Insects net is one of the equipments which are commonly used to actively collect the fly insects, the bag of the net is mostly and generally constructed from a lightweight mesh to minimize damage to delicate the wings of the insects as butterflies, grasshopper, dragonflies. One more called fooding square is the equiment commonly used to collect the insects under the ground in the soid (soil insects) this technical was

imported from Germany, Although it is new technical but currently applying widely and it is said to be a scientific technique nowaday, the material contruced from steel, cubes, hollow in both sides, the lenght equal the width equal 60cm, the height is 20cm.

The boxes (Appendix 7.a) used to save the insctes are small, cylindrical with lids. Microscope (Appendix 8.a) was the facility used to identify the insect, It is a device used to observe insects with small size which can not be observed visually by creating a magnified image of the object. In order to have the photos of the insects, it is required one more equipment called Optilab, It acts as a transmission facilities image from the microscope to the computer, easier for users to capture images from the microscope, save the images and identify.

A book used to identify the insect was “INSECT and SPIDERS’’ (Pocket natural) (Appendix 8.b). This book guide covers the most important families of insects, spiders, and their relatives. Together with a selection of other arthropods. It used to compare, easy to use and illustrated with stunning photographs,

3.4 Sampling technique(s) and Procedure

After 2 days of doing survey, Starting to do the observation was decided , it was on every weekend. All the data was collected in 4 different farms, during the observation time.

To collect the insects with the insects net, It must be in the scientific methods, and follow the rules, could not used hand to catch the insects. This is considerably as one of the most difficult steps for the research. The insect net is swept back and forth through vegetation quickly turning the opening from side to side and following a shallow figure follow eight patterns. Collecter walked forward while sweeping, and the net was moved through plants and grasses with force. Sweeping continues until the end of rows and then

the net is flipped over, it must be careful to get insects into the boxes. After that, the number of insect must be counted for the data, there approximately counted the number of each insects and wrote in a figures paper.

In order to get the soil insects, flooding square is applied as a scientific method, the advantace of this method is to protect the soil and also the plant by avoiding the task of digging. There were no dig,no negative impact to the farms. Firstly, chosing the place where the flooding square could putted to get the soil insects, the location shoud be represented for all area in the farms, at least 4 places for the collecting, and the point where was the location in the middle of middle of junction between the 4 corners of the farms. Putting the fooding square into the soil, 10 centimeters below and 10 centimeters above the soil with force. And filling the flooding square by water, wait until some insects crawling out of the ground, carefuly get it and put it into the boxes, to keep the insects damage themselves or trying to escape, it is required to used alcohol used to kill and keep the larval or insects. After finishing all the steps of collecting insects, the insects shoud be identified as soon as possible, the place where used to identify was the labotory of Plant Protecttion Department which was belongs to faculty of agriculture,

The process of identifying included many steps,a basic to identify an isects that you have been observing, it required how many legs the insects have, be clearly know and understand that if an insect, it most likely have six legs, out of six legs, it can be an other species as spider with eight legs, then need to see that the insect have any wings or not, and the insects have any noticeable antennae or feelers appendages, then finally see the color of the insect, based on those information, by using the insects identification book to indentify it is an insect or not and also find the name of the insects, after finding

the name, Microsoft Excel workbook was wrote for all the result, made it as a data table for later making model and interpretationt those data, there were at least four times to do the observation for, after 1 month of doing collecting, there were 75 differences insect species for 4 total time of observation that found, and finish the observation job. Started to learn how to use the software and how to make and run a model, interpert and analys the date to have the result.

3.5 Data Analysis

After collecting and identifying all insects, Microsoft Excel was used to calculate the total of number in insect species, SIMILE software was used to run the model with each data for each time in each farm and run the model, it mostly analyzed the data though creating table and creating plotter. The temperature data information supported by Weather Station Sriwijaya University for Indralaya location. Climate data for other three farms in Palembang were supported by Indonesian Agency for Climatology, Meteorology and Geophysics (Table.1). The table describle the temperature date in two differences location and four differences priod from september 27 to october 18. Based on the time that the observation did, the time was in the morning in Indralaya and afternoon in Palembang.

Table 1. *The tempreture data in Palembang and Indralaya during the observation*

Location	**Palembang**		**Indralaya**	
Time	8AM	**1PM**	**8AM**	1PM
September 27	22ºC	**32ºC**	**25ºC**	34ºC
October 4	23ºC	**34ºC**	**24ºC**	35ºC
October 11	23 ºC	**35ºC**	**24ºC**	25ºC
October 18	24 ºC	**34ºC**	**21ºC**	33ºC

PART IV: RESULTS

4.1 Insects diversity in the research area

After collecting and identifying all the insects, there were many fly insects and soil insects as shown in the (Figure 1a. (&b **)** that found and indentified, there were 75 insects included 68 flying insects such as grasshopper, bees family, flies family, beetles family, ladybirds or ants and 7 soil insects such as cricket, sand waps, in all research area.

a) *Flying insects was found in observation area*

b) *Soil insects*

Figure 1. All insects that found and indentified in the observation area **a)** *Flying insects (above)* ***b)*** *Soil insects (below)*

Beside 75 insects found, many non - insctes also was found (Figure 2) such as spider, Centipede, because the research related to soil insects so after indentifying to have results, non – insect was igroned.

Figure 2: *Non – insect was also found in the observation area*

4.2 Insects biodiverstiy at all observation area

Data which were obtained were subjected to analysis and put it in the table of data as following table.

All table depicts the number of insects for four observation in four different vegetable farms. Sangkuriang Saka for eggplant, Kenten Ashar for cucumber, Kenten Sukamaju for Green Bean and Chili in Indralaya. In each (Table 6.1)**,** the number of

insect species different and also the number of insects in each time of observation. For the first observation, the total number of insects was 56 species, Tab included 30 species in eggplants, 20 species in cucumber farm, 24 species in green bean farm at the same temperature of 32 ºC and 30 for chili at 25 ºC.

For the second obseration, overall, there is a slight increase not only at the total of insect at all farms but also at the temperature (Table 6.2). Specifically, the total number of species increase from 56 to 63, the number of species increase slighly from 34 to 40 species at eggplants farm, following at the same trend are cucumber and green bean farm from 20 to 28 species and 24 to 25 species at the same temperature of 34 ºC. At chili farm, the number of insects species was also increase from 30 to 38 species while the temperature decrease slightly from 25 to 24 ºC.

For the third observation, the total number of insects species was increased from 63 to hit a high with 71 species (Table 6.3). The number of insects species went up from 40 to 43 species in eggplant farm while the number of species at cucumber and green bean went down slightly to 25 and 24 compare with the second observation at the same 35 ºC. To contrary, the number of species at chili farm went down significant to hit a low at 27 species while the temperature stay unchanged compare with the second observation.

And the last observation, the temperature drop slightly from 35 ºC to 34 ºC at Palembang followed by the same decrease trend at Indralaya from 24 ºC to 21 ºC (Table 6.4), the total number of insects species also go down from 71 to 65 for all observation, to be specific, the number of insects species at eggplant decrease from 43 to 40 species, there was also a decline from 25 to 19 species at cucumber farm, and from 24 to 21

species at green bean farm. But there was an opposed with chili farm, the number of species go up from 27 to 31 species.

4.3. Dynamic of insects population under the changing of environment.

4.3.1 How to run the Simile software

After getting the raw data for observation, analyzing and explaining the data were started by using the the model of SIMILE software as showing below.

The graph (Figure. 3) describle the relationship between number of insects and insects reproduction and insects mortality, the relationship between number of plant and number of plant increase and decrease. In additional, temperature is a variable that contribute the correlation in the diagram and it is also the main factor that impacts to the number of insects through affecting the insects mortality, impacts to number of plant through affecting to the number of plant increase. In the model, the data should be putted in each compartments, flows, and variable to run the model. In each cases, the data must be different as long as logical with the data.

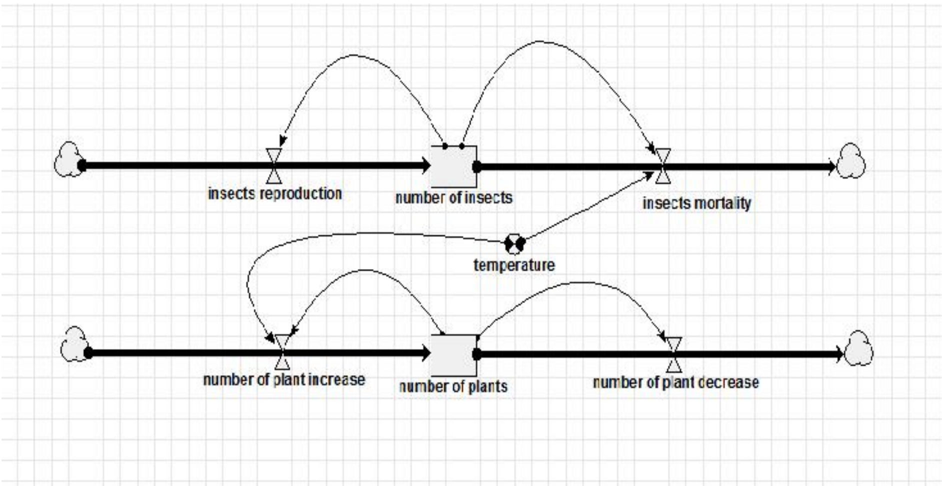


Figure 3. *The grap shows the relationship among each variable.*

After finishing the data, started to run the model as on the diagram (Figure 4.) , run setting should be checked to be logical, start to run the model throught run control keys.

In the model, to see the relationship between temperature and number of insects, insects reproduction and insects mortality, creating the plotter and table to see the correction by adding those variables as below. To get the diagram, graph or table, press the run the simulation.

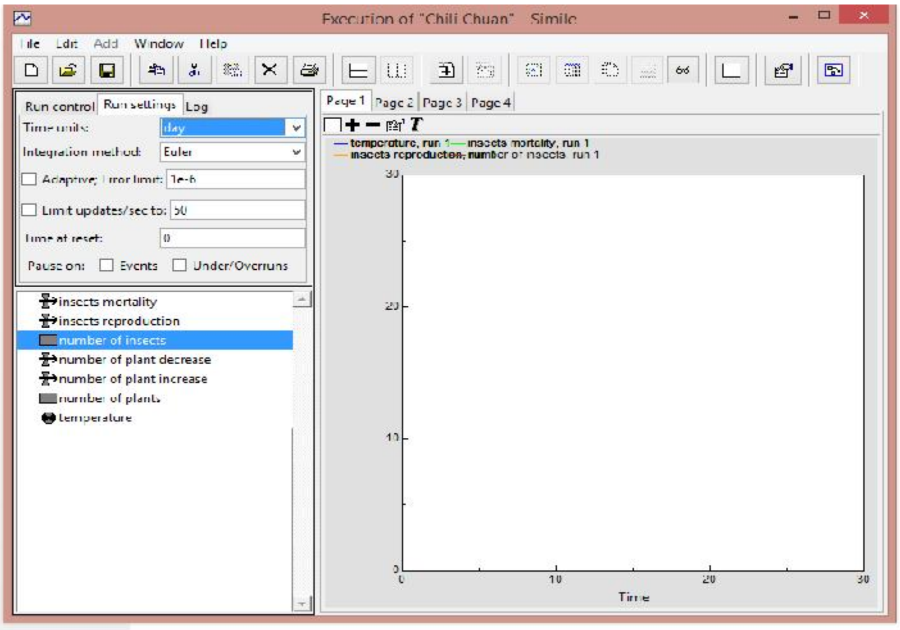
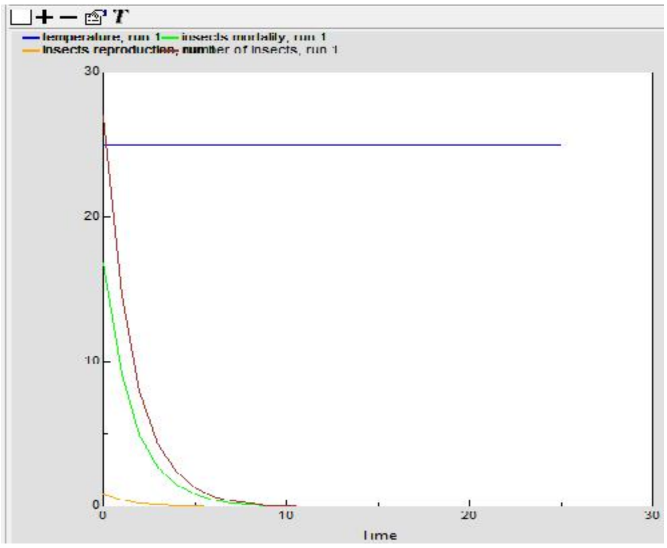


Figure 4. *The model before running*

And the result as (Figure 5.) to see the trend of insects look at the (Line graph 1) (left) and the (Table. 1) **(**right). It demonstrates the relationship of temperature and number of insects, insect reproduction and insect mortality.



Time \ Name	insects mortality	insects reproduction	number of insects	temperature
0	16.6750	0.6100	27.0000	25
1	9.1376	0.4386	14.6201	25
2	4.9479	0.2375	7.9163	25
3	2.6792	0.1286	4.2867	25
4	1.4508	0.0696	2.3212	25
5	0.7856	0.0377	1.2569	25
6	0.4254	0.0204	0.6806	25
7	0.2303	0.0111	0.3685	25
8	0.1247	0.0060	0.1995	25
9	0.0675	0.0032	0.1081	25
10	0.0366	0.0018	0.0585	25
11	0.0198	0.0010	0.0317	25
12	0.0107	0.0005	0.0172	25
13	0.0058	0.0003	0.0093	25
14	0.0031	0.0002	0.0050	25
15	0.0017	0.0001	0.0027	25
16	0.0009	4.4e-005	0.0015	25
17	0.0005	2.4e-005	0.0008	25
18	0.0003	1.3e-005	0.0004	25
19	0.0001	7.0e-006	0.0002	25
20	0.0001	3.8e-006	0.0001	25

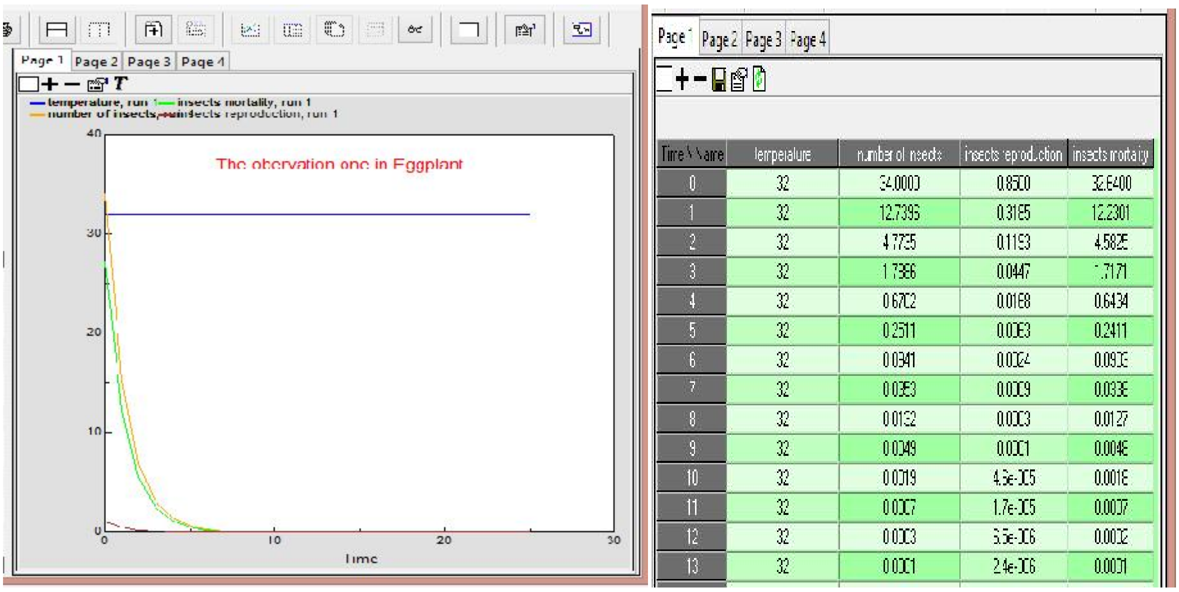
Figure 5. *The results of observation*

We acknowledge that temperature change will affect to host plant physiology, growth, species assemblages and successional processes, and these all have an impact the relationship between plants and insects, due to the complexity of indirect interaction between climate, vegetable and insects, it is very difficult to predict, but there is evidence that larger population will not depend on the response of the vegetation but the effects of predator and parasitoids will need to consider,

4.3.2 Modeling and interpretations

Now, the data will be interpreted.

Observation 1 (September 27)

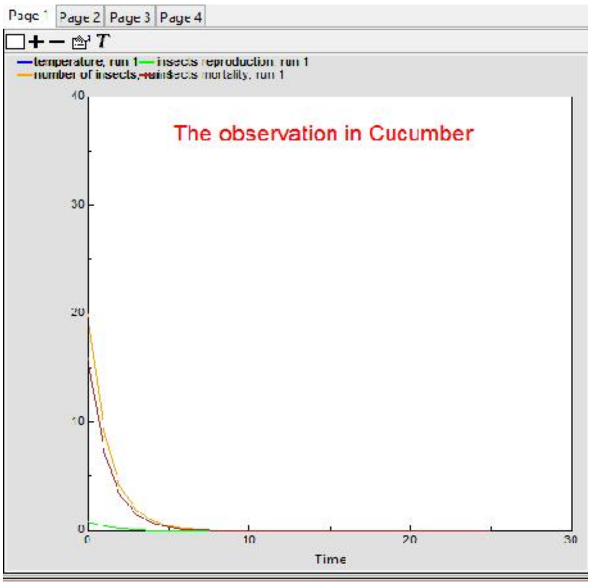


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	32	34.0000	0.8500	32.6400
1	32	12.7396	0.3185	12.2301
2	32	4.7735	0.1193	4.5825
3	32	1.7386	0.0447	1.7171
4	32	0.6702	0.0168	0.6434
5	32	0.2511	0.0063	0.2411
6	32	0.0941	0.0024	0.0903
7	32	0.0353	0.0009	0.0338
8	32	0.0132	0.0003	0.0127
9	32	0.0049	0.0001	0.0048
10	32	0.0019	4.3e-005	0.0018
11	32	0.0007	1.7e-005	0.0007
12	32	0.0003	6.5e-006	0.0002
13	32	0.0001	2.4e-006	0.0001

Figure 6.a: *The modeling of the observation 1 in eggplant vegetable farm*

The line graph (Figure 6.a) shows the data about the correlation between temperatures, the number of insects and the percentage of insect reproduction and mortality that conduct in the eggplant field for the period of 25 days.

It is clear that there is a strong decrease in the proportion of insect reproduction and mortality and the quality of insects over the period shown. The proportion of insect mortality and reproduction decline dramatically for the first ten days while the temperature stays unchanged. The percentage of insect reproduction drops significantly from 0.85percent to 0 for the first nine. Similarly, the figure for insect mortality witnesses a remarkable decrease whereas the number of insects fluctuates slightly between 34 and 0 insect species. By comparison, the temperature stabilizes during the 25 days at 32 Celsius degree

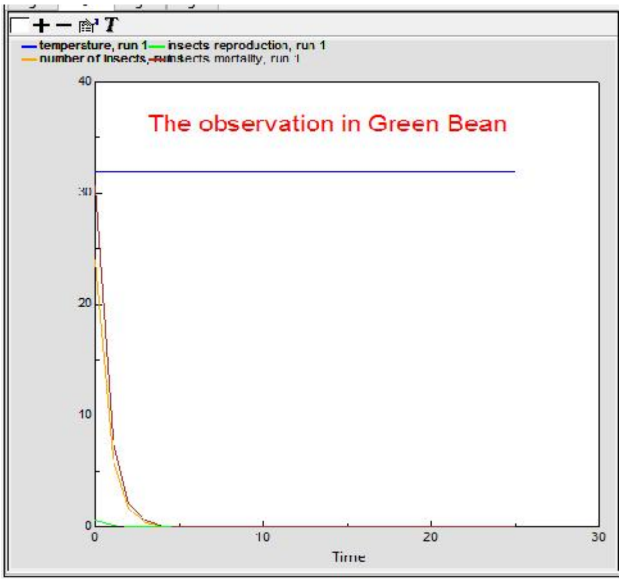


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	32	20.0000	0.5000	19.2000
1	32	7.4539	0.1873	7.1941
2	32	2.8079	0.0702	2.6953
3	32	1.0521	0.0263	1.0100
4	32	0.3942	0.0099	0.3785
5	32	0.1477	0.0037	0.1413
6	32	0.0553	0.0014	0.0531
7	32	0.0207	0.0005	0.0199
8	32	0.0078	0.0002	0.0075
9	32	0.0029	0.0001	0.0028
10	32	0.0011	2.7e-005	0.0010
11	32	0.0004	1.0e-005	0.0004
12	32	0.0002	3.8e-006	0.0001
13	32	0.0001	1.4e-006	0.0001

Figure 6.b: *The modeling of the observation 1 in cucumber vegetable farm*

The graph (Figure 6.b) demonstrates the change in the number of insect and the proportion of insects reproduction, insects mortality over the period of conducting 25 days in cucumber vegetable farm.

Overall, quality of insects and the proportion of insect reproduction and mortality followed the trend with the former of going down for all the priod while the temperature remain stable at 28 Celsius degree**.** To specific, the rate of insects reprocuction sharply decrease from 0.5to 0.0001 for the first nine days, followed by a light step decrease to 0 in last days. Similarly, There was a continous and significant decrease in the number of insects from 20 to 0 and the proportion of insects mortality from 19.2 to 0 first day to thirteen. Interestingly, at day tentyfive, all of the insects and proportion of insects reproduction and mortality his a low of 0.



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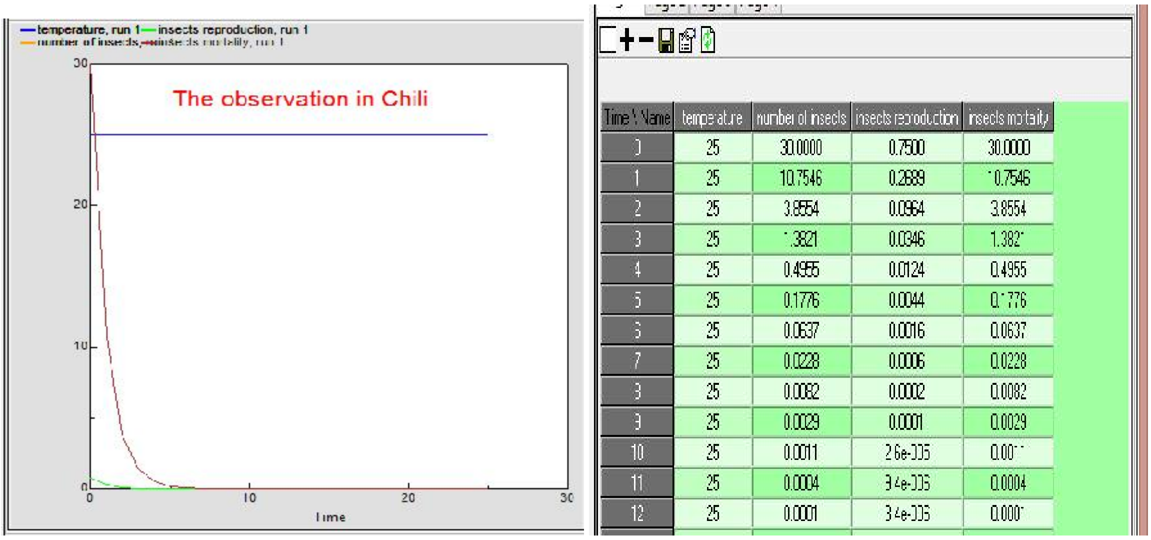
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	32	24.0000	0.6000	30.7200
1	32	6.2773	0.1569	8.0356
2	32	1.6421	0.0411	2.1019
3	32	0.4295	0.0107	0.5498
4	32	0.1124	0.0028	0.1438
5	32	0.0294	0.0007	0.0376
6	32	0.0077	0.0002	0.0098
7	32	0.0020	0.0001	0.0026
8	32	0.0005	1.3e-005	0.0007
9	32	0.0001	3.4e-006	0.0002

Figure 6.c: *The modeling of the observation 1 in green bean vegetable farm*

This line graph (Figure 6.c) illustrates the effect of temperature to the decline of quantities of insects, which is done through observation in Green Bean within 25 days.

In general, there was a dramatic decrease in the number of insects, insect reproduction and insect mortality due the effect of a specific temperature. The rate of insect mortality is always higher than those of insect reproduction, number of insects at any time. For instance, in the rate of insect's mortality, the first day experienced a considerable fall from 30.7 to 8.03 with temperature of 32 Celsius degree, followed by a slight fall to 0.54 in the next 2 days. Subsequently, the figure went down to nearly 0 in the ninth day. At the same temperature condition , the rate of insects reproduction which dropped moderately from 0.6 to approximately 0.15 for the first day decreased significantly to nearly zero in the seventh day. Similarly, after a significant drop from about 24 to around 6.27 for the first day, the number of insects fell gradually to 0.42 for the next 2 days, followed by a plummet to the lowest point of 0 in the ninth day.



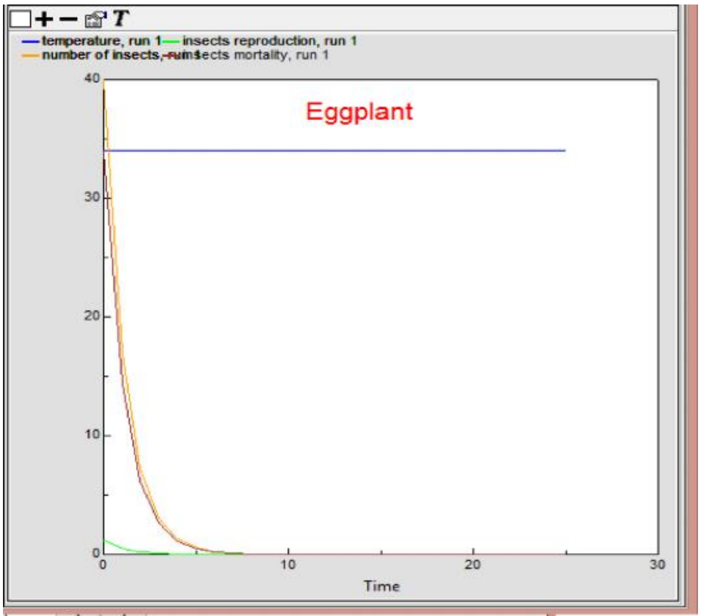
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	25	30.0000	0.7500	30.0000
1	25	10.7546	0.2689	10.7546
2	25	3.8554	0.0964	3.8554
3	25	1.3821	0.0346	1.3821
4	25	0.4955	0.0124	0.4955
5	25	0.1776	0.0044	0.1776
6	25	0.0637	0.0016	0.0637
7	25	0.0228	0.0006	0.0228
8	25	0.0082	0.0002	0.0082
9	25	0.0029	0.0001	0.0029
10	25	0.0011	2.6e-005	0.0011
11	25	0.0004	9.4e-006	0.0004
12	25	0.0001	3.4e-006	0.0001

Figure 6.d: *The modeling of the observation 1 in chili vegetable farm*

The graph (Figure 6.d) describles the change in the number of insect and the proportion of insects reproduction, insects mortality over the period of conducting 25 days in Chili vegetable farm.

As can be seen from the graph, there was a continuous decrease in the number of insects, insect reproduction and insect mortality due the effect of a specific temperature . While the temperature constants at 25 Celsius degree, The proportion of insect mortality and reproduction decline dramatically for the first in order ten and twelve days. The percentage of insect reproduction drops significantly from 0.75percent to 0.0001 for the first nine. Similarly, there was a continous and significant decrease in the number of insects from 30 to aprroximate 0. Surprisingly, there was the same decline in the proportion of insects mortality and the number of insects from 30 to 0 at twelve day. By comparison, the temperature stabilizes during the 25 days at 25 Celsius degree

Observation 2 (October 4)



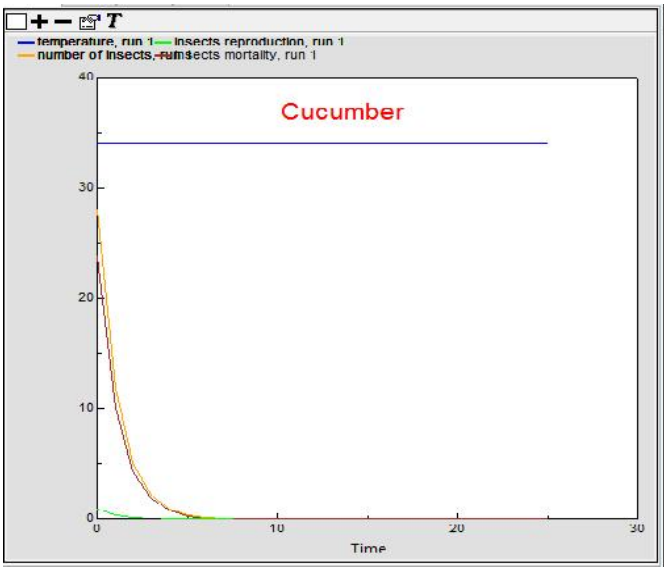
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	40.0000	1.2000	34.0000
1	34	17.0015	0.5100	14.4513
2	34	7.2263	0.2168	6.1423
3	34	3.0714	0.0921	2.6107
4	34	1.3055	0.0392	1.1097
5	34	0.5549	0.0166	0.4716
6	34	0.2358	0.0071	0.2005
7	34	0.1002	0.0030	0.0852
8	34	0.0426	0.0013	0.0362
9	34	0.0181	0.0005	0.0154
10	34	0.0077	0.0002	0.0065
11	34	0.0033	0.0001	0.0028
12	34	0.0014	4.2e-005	0.0012
13	34	0.0006	1.8e-005	0.0005
14	34	0.0003	7.5e-006	0.0002
15	34	0.0001	3.2e-006	0.0001

Firgure 7.a: *The modeling of the observation 2 in eggplant vegetable farm*

The graph (Figure7.a) illustrates how the quantity of insects and the proportion of insect reproduction and insect mortality changed over the period of 25 days in Eggplant vegetable farm at the same temperature.

It is clear that the number of insects and the proportion of insects reproduction and insect mortality followed the trend of a pluge for most of the peroid. In details, there were significant fall in the number of insects from 40 to 0 between the first day to the day of

fifteen by constant at 34 Celsius degree. Similarly, the percentage of insect reproduction went up quickly for the first two days between 12 and 0.51 before slight delice until 0 in the day of eleven at the same stablize at 34 Celsius degree. Interestingly, there was a same significant decreased trend of insect motality for the first four days before hit a low of 0 at the day of fifteen.



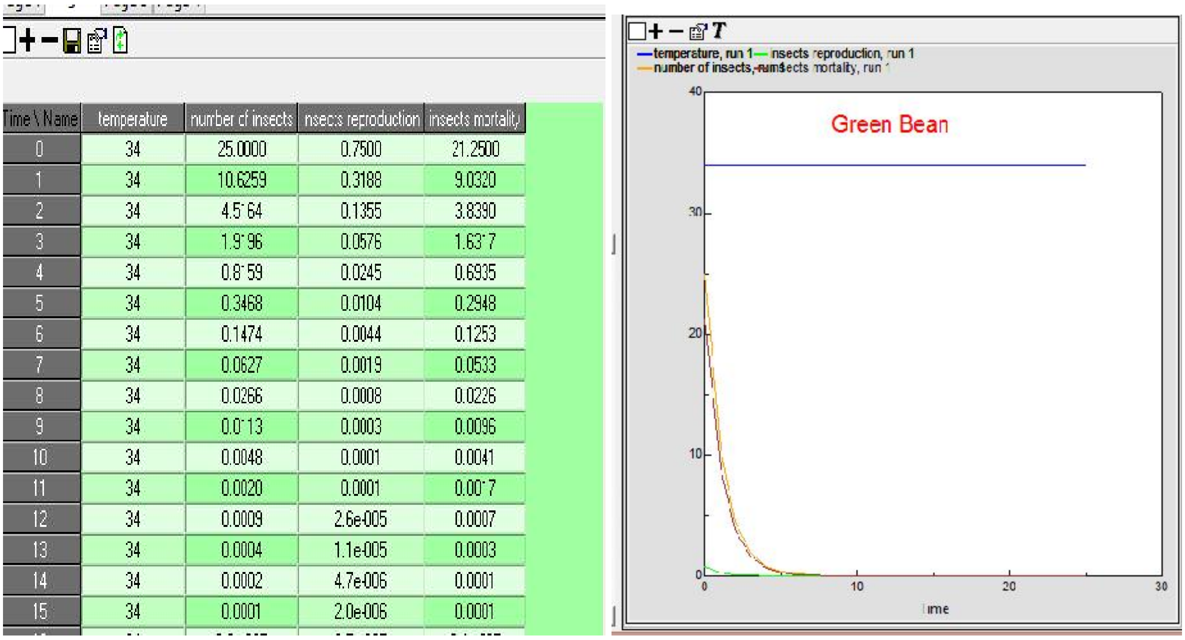
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	28.0000	0.8400	23.8000
1	34	11.9010	0.3570	10.1159
2	34	5.0584	0.1518	4.2996
3	34	2.1500	0.0645	1.8275
4	34	0.9138	0.0274	0.7768
5	34	0.3884	0.0117	0.3301
6	34	0.1651	0.0050	0.1403
7	34	0.0702	0.0021	0.0596
8	34	0.0298	0.0009	0.0254
9	34	0.0127	0.0004	0.0108
10	34	0.0054	0.0002	0.0046
11	34	0.0023	0.0001	0.0019
12	34	0.0010	2.9e-005	0.0008
13	34	0.0004	1.2e-005	0.0004
14	34	0.0002	5.3e-006	0.0001
15	34	0.0001	2.2e-006	0.0001

Figure 7.b: *The modeling of the observation 2 in cucumber vegetable farm*

The graph(Figure 7.b) illsutrates the changed in the number of insects and the percentage of insects mortality and insect's reproduction at the temperature of 34 Celsius degree in Cumcumer vegetable farm.

Genrerally, the quantity of insects and the percentage of insect mortality and insect reproduction are the same trend of significant decrease for few first days and hit a low of. To specific, the number of insects went down quickly for the first three days from 29 to 5 before decrease to be 0, there was similarly of down trend with the percentage of insect mortality to sink to a low of 0 at the day of fifteen. In the same way, the proportion of

insect’s reproduction slight decrease from 8.4 until the bottom of 0 at the day of elevent while the temperature stay unchanged at 34 Celsius degree. Interestingly, all the number of insects, insect mortality and insect reproduction were the same trend of hit a low at 0 after first half of experiment.



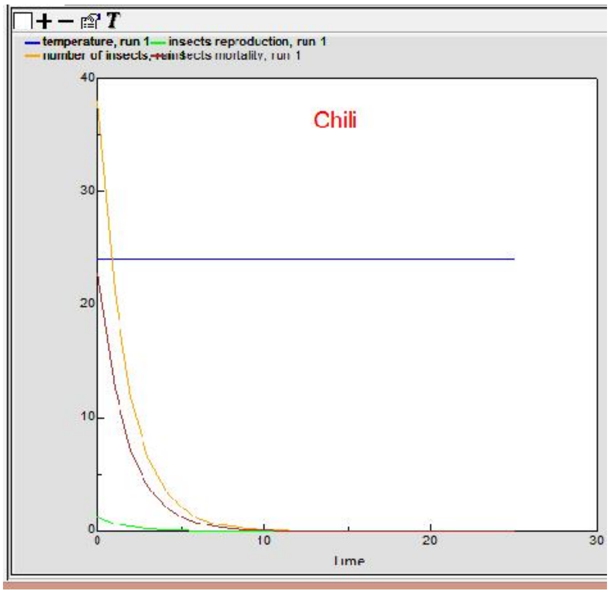
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	25.0000	0.7500	21.2500
1	34	10.6259	0.3188	9.0320
2	34	4.5'64	0.1355	3.8390
3	34	1.9'96	0.0576	1.63'7
4	34	0.8'59	0.0245	0.6935
5	34	0.3468	0.0104	0.2948
6	34	0.1474	0.0044	0.1253
7	34	0.0627	0.0019	0.0533
8	34	0.0266	0.0008	0.0226
9	34	0.0'13	0.0003	0.0096
10	34	0.0048	0.0001	0.0041
11	34	0.0020	0.0001	0.00'7
12	34	0.0009	2.6e-005	0.0007
13	34	0.0004	1.1e-005	0.0003
14	34	0.0002	4.7e-006	0.0001
15	34	0.0001	2.0e-006	0.0001

Figure 7.c: *The modeling of the observation 2 in green bean vegetable farm*

The graph (Figure 7.c) shows the correlation between the temperature and the changed in the quantity of insect and the proportion of insect mortality and insect reproduction in Green bean vegetable in 25 days

Overall, the number of insects and the percentage of insect reproduction and insect mortality went down significant at most of period of first five days before decrease slowly to hit a low of 0 at the middle of 25 days experienced. To be specific, the numner of insect significant decline from 25 to 4 for the first two days and come to 0 at

the day of fifteen while the proportion of insect mortality went down from 7.5 to 1.3 and at the first two day and hit a low at the same day with insects population. Likewise, there was a continous reduction in the porportion of insect reproduction from 7.5 to 0 at the day of elevent at the same constant of 34 degree.



Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	24	38.0000	1.1400	22.8000
1	24	21.1300	0.6339	12.6780
2	24	11.7494	0.3525	7.0497
3	24	6.5333	0.1960	3.9200
4	24	3.6329	0.1090	2.1797
5	24	2.0201	0.0606	1.2120
6	24	1.1233	0.0337	0.6740
7	24	0.6246	0.0187	0.3748
8	24	0.3473	0.0104	0.2084
9	24	0.1931	0.0058	0.1159
10	24	0.1074	0.0032	0.0644
11	24	0.0597	0.0018	0.0358
12	24	0.0332	0.0010	0.0199
13	24	0.0185	0.0006	0.0111
14	24	0.0103	0.0003	0.0062
15	24	0.0057	0.0002	0.0034
16	24	0.0032	0.0001	0.0019
17	24	0.0018	0.0001	0.0011
18	24	0.0010	2.3e-005	0.0006
19	24	0.0005	1.5e-005	0.0003
20	24	0.0003	9.1e-006	0.0002
21	24	0.0002	5.1e-006	0.0001
22	24	0.0001	2.8e-006	0.0001
23	24	0.0001	1.6e-006	[illegible]

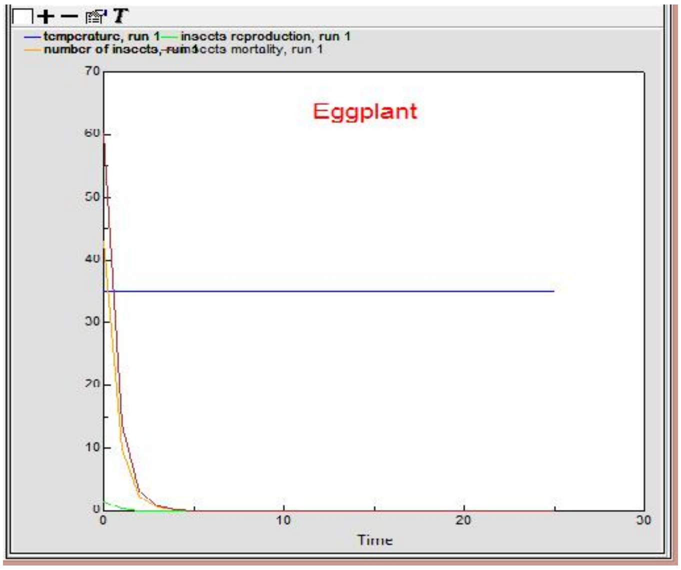
Figure 7.d: *The modeling of the observation 2 in chili vegetable farm*

The graph (Figure 7.d) illustrate how the quantity of insects and the proportion of insect reproduction and insect mortality changed over the period of 25 days in Chili vegetable farm at the same temperature.

As can be seen for the graph, the number of insects and the proportion of insect reproduction and insect mortality followed the down trend most of the peroid and sink to a low of 0 at few last day of experienced. To be specific, there were significant fall in the number of insects from 38 to 0 between the first day to the day oftwenty three by constant at 24 degree. Similarly, the percentage of insect reproduction went up quickly for the first two days between 1.1 to 0.3 before slight decrease until 0 in the day of

seventeen at the same stablize at 24 degree. Interestingly, there was a same significant decreased trend of insect motality from 22.8 to hit a low at 0 at the day of twently two.

Observation 3 (October 11)

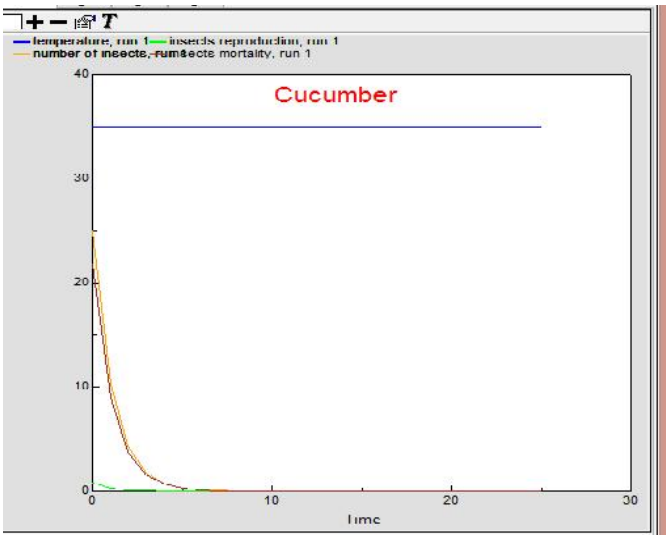


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	35	43.0000	1.2000	60.2000
1	35	9.5552	0.2555	13.7945
2	35	2.2578	0.0577	3.1608
3	35	0.5174	0.0155	0.7243
4	35	0.1135	0.0033	0.1662
5	35	0.0272	0.0008	0.0380
6	35	0.0062	0.0002	0.0087
7	35	0.0014	4.3e-005	0.0020
8	35	0.0003	9.8e-006	0.0005
9	35	0.0001	2.2e-006	0.0001

Figure 8.a: *The modeling of the observation 3 eggplant vegetable farm*

This line (Figure 8.a) graph illustrates the effect of temperature to the fall of quantities of insects, which is done through observation in Eggplant in 25 days.

In general, there was a significant decrease in the number of insects, insect reproduction and insect mortality due the effect of a specific temperature. The rate of insect mortality is always higher than those of insect reproduction, number of insects at any time. In detail, in the rate of insect’s mortality, the first day experienced fall from 60 to 13 with temperature of 35 centigrade, followed by a slight fall to 3 to 0 in the next 7 days. And the figure went down to nearly 0 in the ninth day. At the same temperature condition , the rate of insects reproduction which dropped slightly from 1.2 to approximately 0 for the first 6 day decreased significantly to nearly 0 in the seventh day. Similarly, after a dramatic drop from about 43 to around 9 for the first day, the number of insects fell slowly to approximate 0 for the next 2 days, followed by a plummet to the lowest point of 0 in the ninth day.

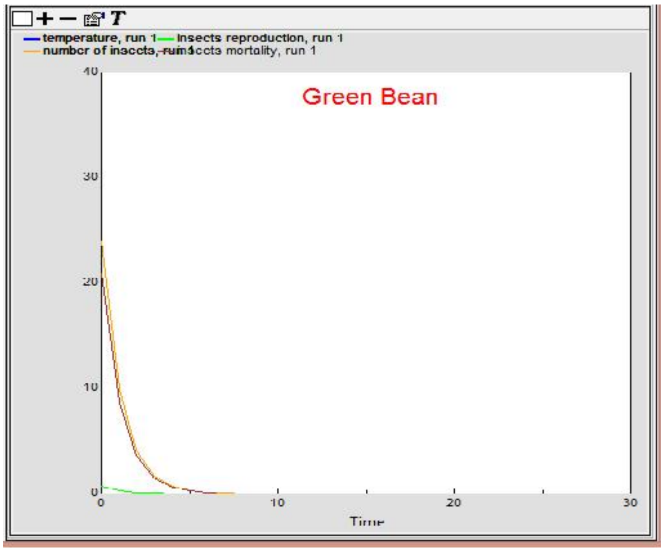


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	35	25.0000	0.7500	21.8750
1	35	10.3401	0.3102	9.0476
2	35	4.2757	0.1283	3.7421
3	35	1.7638	0.0531	1.5477
4	35	0.7316	0.0219	0.6402
5	35	0.3026	0.0091	0.2648
6	35	0.1252	0.0038	0.1095
7	35	0.0518	0.0016	0.0453
8	35	0.0214	0.0006	0.0187
9	35	0.0089	0.0003	0.0077
10	35	0.0037	0.0001	0.0032
11	35	0.0015	4.5e-005	0.0013
12	35	0.0006	1.9e-005	0.0005
13	35	0.0003	7.8e-006	0.0002
14	35	0.0001	3.2e-006	0.0001

Figure 8.b: *The modeling of the observation 3 cucumber vegetable farm*

The graph (Figure 8.b) demonstrates the change in the number of insect and the proportion of insects reproduction, insects mortality over the period of conducting 25 days in cucumber vegetable farm.

Overall, quantity of insects and the proportion of insect reproduction and mortality followed the trend with the former of going down for all the priod while the temperature remain stable at 35 Celsius degree. To specific, the rate of insects reproduction sharply decrease from 0.7500 to 0.0003 for the first nine days, followed by a light step decrease to 0 in last days. Similarly, There was a continous and significant decrease in the number of insects from 25 to 0 and the proportion of insects mortality from 21.8 to 0.0001 first day to fourteen. Interestingly, at day twenty five, all of the insects and proportion of insects reproduction and mortality at a lowest point of 0.

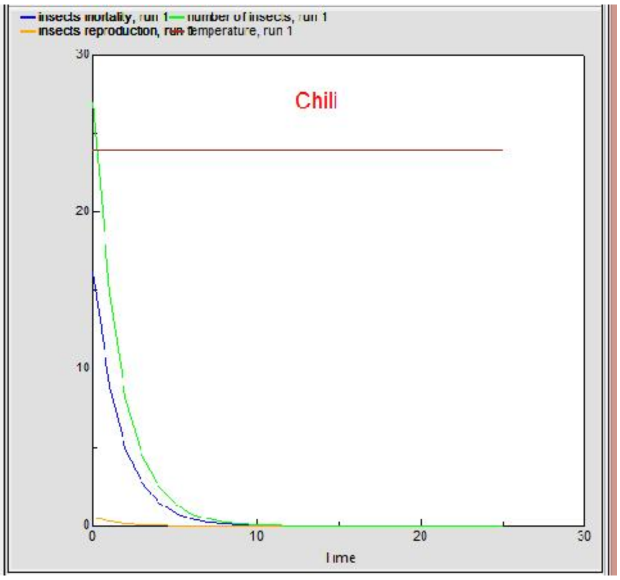


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	35	24.0000	0.7230	21.0000
1	35	9.9265	0.2978	8.6857
2	35	4.1056	0.1232	3.5924
3	35	1.6981	0.0509	1.4855
4	35	0.7023	0.0211	0.6145
5	35	0.2905	0.0037	0.2542
6	35	0.1201	0.0036	0.1051
7	35	0.0497	0.0015	0.0435
8	35	0.0206	0.0006	0.0180
9	35	0.0085	0.0003	0.0074
10	35	0.0035	0.0001	0.0031
11	35	0.0015	4.4e-005	0.0013
12	35	0.0006	1.8e-005	0.0005
13	35	0.0002	7.5e-006	0.0002
14	35	0.0001	3.1e-006	0.0001

Figure 8.c: *The modeling of the observation 3 green bean vegetable farm*

The graph (Figure 8.c) variation how the number of insects and the percentage of insects mortality and insect reproduction changed at the temperature of 35 Celsius degree in Green bean vegetable farm.

Overall, the quantity of insects and the percentage of insect mortality and insect reproduction significantly decrease for few first days and slightly drop to hit a low of 0 at the first half period of experiment with the same temperature of 35 Celsius degree**.** To specific, the number of insects falldown quickly for the first three days from 24 to 4 before decrease to sink to a low of 0, there was similarly of down trend with the percentage of insect's mortality at the day of fourteen. In the same way, the proportion of insect reproduction slightly decrease until the bottom of 0 at the day of ten while the temperature stay unchanged at 35 Celsius degree. Interestingly, all the number of insects, insect mortality and insect reproduction were the same trend of hit a low at 0 after first half of experienced at lastly the day of fourteen.



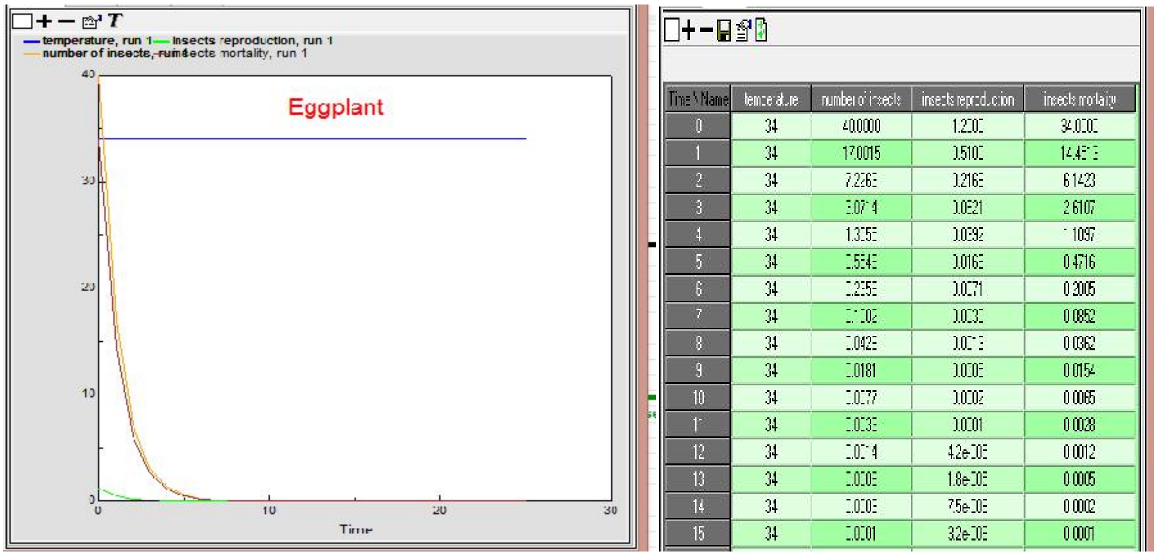
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	24	27.0000	0.5400	16.2000
1	24	14.8500	0.2971	8.9100
2	24	8.1730	0.1635	4.9038
3	24	4.4967	0.0899	2.6980
4	24	2.4740	0.0495	1.4844
5	24	1.3612	0.0272	0.8167
6	24	0.7489	0.0150	0.4493
7	24	0.4120	0.0082	0.2472
8	24	0.2267	0.0045	0.1360
9	24	0.1247	0.0025	0.0748
10	24	0.0686	0.0014	0.0412
11	24	0.0378	0.0008	0.0227
12	24	0.0208	0.0004	0.0125
13	24	0.0114	0.0002	0.0069
14	24	0.0063	0.0001	0.0038
15	24	0.0035	0.0001	0.0021
16	24	0.0019	3.8e-005	0.0011
17	24	0.0010	2.1e-005	0.0006
18	24	0.0006	1.2e-005	0.0003
19	24	0.0003	6.3e-006	0.0002
20	24	0.0002	3.5e-006	0.0001
21	24	0.0001	1.9e-006	0.0001
22	24	0.0001	1.1e-006	3.2e-005

Figure 8.d: *The modeling of the observation 3 chili vegetable farm.*

The graph (Figure 8.d) demonstrates the correlation between the temperature and the quantity of insect and the proportion of insect mortality and insect reproduction in chili vegetable farm in 25 days.

Generally, the number of insects and the percentage of insect's reproduction and insect's mortality went down significant at most of period of first four days before decrease slowly to hit a low of 0 at few last days of 25 days experiment when the temperatur stay unchanged at 24 Celsius degree. To be specific, there was a pluge in the number of insects from 27 to 2 for the fist four day, followed by the slight decrease from 2 to 0 at the three last day before the end 25 days of experienced. Similarlly, there was a continous reduction in the porportion of insect mortality from 16.2 to 0 at the day of twenty one at the same constant of 24 Celsius degree. Interestingly, the proportion of insect reproduction decreased slightly with downward trend to hit a low of 0 in the day of fifteen.

Observation 4 (October 18)

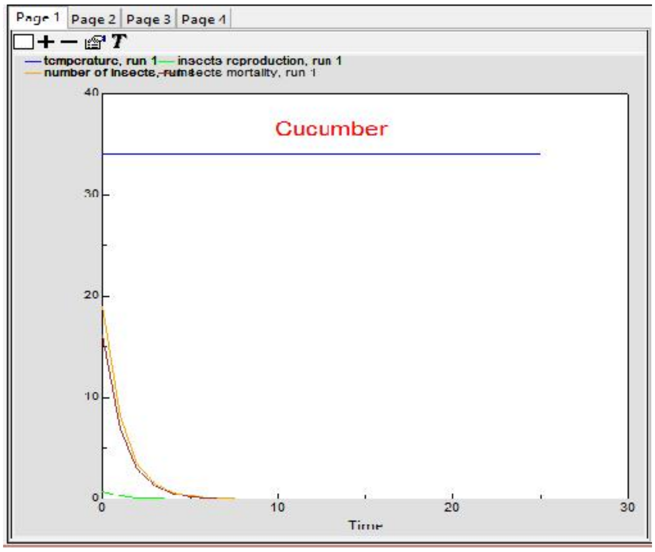


Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	40.0000	1.2000	34.0000
1	34	17.0015	0.5100	14.4513
2	34	7.2263	0.2168	6.1423
3	34	3.0714	0.0921	2.6107
4	34	1.3055	0.0392	1.1097
5	34	0.5548	0.0166	0.4716
6	34	0.2358	0.0071	0.2005
7	34	0.1002	0.0030	0.0852
8	34	0.0425	0.0013	0.0362
9	34	0.0181	0.0005	0.0154
10	34	0.0077	0.0002	0.0065
11	34	0.0033	0.0001	0.0028
12	34	0.0014	4.2e-005	0.0012
13	34	0.0006	1.8e-005	0.0005
14	34	0.0003	7.5e-006	0.0002
15	34	0.0001	3.2e-006	0.0001

Figure 9.a: *The modeling of the observation 4 eggplant vegetable farm.*

The graph (Figure 9.a) describes the change in the number of insect and the proportion of insect reproduction, insect mortality by the temperature over the period of conducting 25 days in Chili vegetable farm.

As can be seen from the graph, there was a continuous decrease in the number of insects, insect reproduction and insect mortality due the effect of a same temperature. To specific, while the temperature constants at 34 Celsius degree, the proportion of insect reproduction decline significantly from 1.2 to approximate 0 only in first eleven day. Similarly, the percentage of insect mortality drops quickly from 34 to 6 for the first two day while there was a continuous and significant decrease in the number of insects from 40 to approximate 7, which come to the lowest point at approximate 0 in the day of fifteen, by comparison the temperature stabilizes during the 25 days at 25 Celsius degree



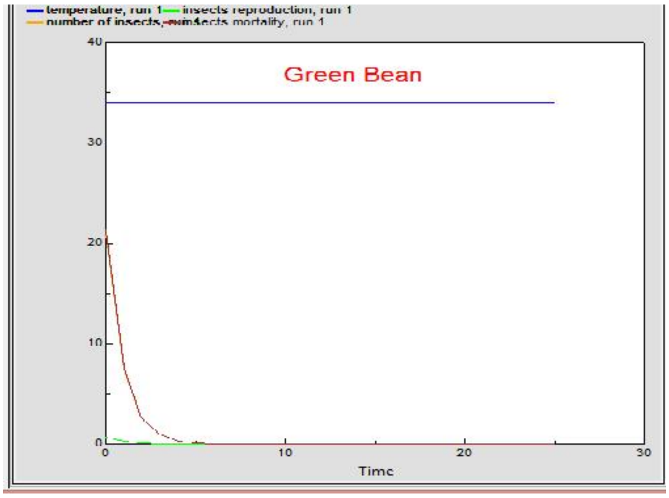
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	19.0000	0.6650	16.1500
1	34	8.1158	0.2842	6.3013
2	34	3.4701	0.1215	2.3495
3	34	1.4830	0.0513	1.2605
4	34	0.6338	0.0222	0.5387
5	34	0.2708	0.0095	0.2302
6	34	0.1157	0.0041	0.0984
7	34	0.0495	0.0017	0.0420
8	34	0.0211	0.0007	0.0180
9	34	0.0090	0.0003	0.0077
10	34	0.0039	0.0001	0.0033
11	34	0.0016	0.0001	0.0014
12	34	0.0007	2.5e-005	0.0006
13	34	0.0003	1.1e-005	0.0003
14	34	0.0001	4.5e-006	0.0001
15	34	0.0001	1.5e-006	4.7e-005

Figure 9.b: *The modeling of the observation 4 cucumber vegetable farm.*

This line graph (Figure 9.b) demonstrates the effect of temperature to the decline of quantities of insects and the proportion of insect mortality and insect reproduction, which is done through observation in Eggplant in 25 days.

In general, there was a significant decrease in the number of insects, insect reproduction and insect mortality due the effect of a specific temperature. The rate of insect's mortality is always higher than those of insect reproduction, number of insects at any time during the observation of 34 Celsius degree. In detail, in the rate of insect mortality, the first day experienced fall from 16.1 to 6.9 with temperature of 35

centigrade, followed by a slight decreased from 6.9 to 0 in the next 14 days. At the same temperature condition, the rate of insect reproduction which dropped slightly from 0.6 to approximately 0 for the first 6 days decreased to nearly zero in the seventh day. Similarly, after a dramatic drop from about 19 to around 8 for the first day, the number of insects fell slowly to approximate 0 for the next 4 days, followed by a plummet to the lowest point of 0 in the ninth day.



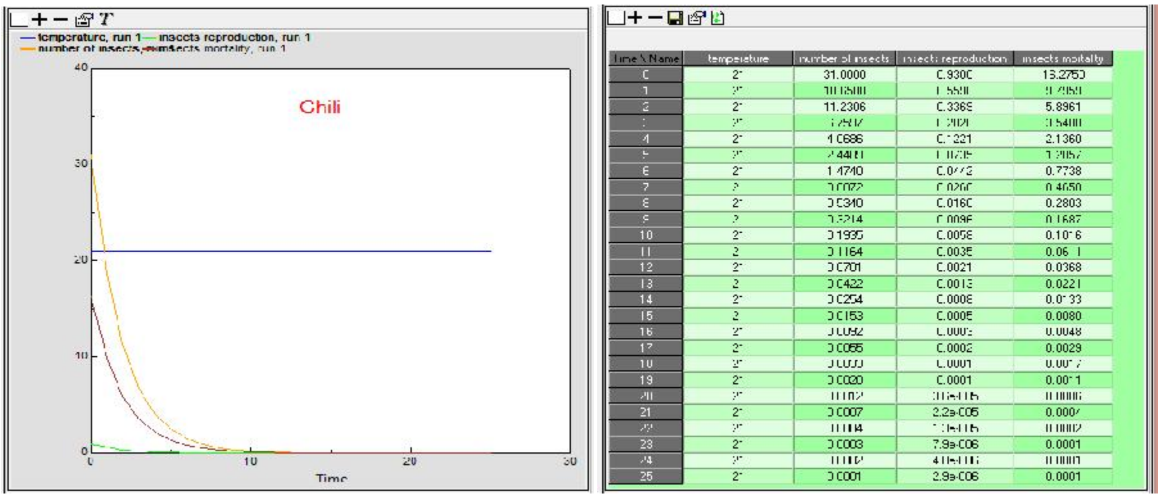
Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	34	21.0000	0.7350	21.4200
1	34	7.4452	0.2606	7.5941
2	34	2.6396	0.0924	2.6924
3	34	0.9358	0.0328	0.9545
4	34	0.3318	0.0116	0.3384
5	34	0.1176	0.0041	0.1200
6	34	0.0417	0.0015	0.0425
7	34	0.0148	0.0005	0.0151
8	34	0.0052	0.0002	0.0053
9	34	0.0019	0.0001	0.0019
10	34	0.0007	2.3e-05	0.0007
11	34	0.0002	8.2e-06	0.0002
12	34	0.0001	2.9e-06	0.0001

Figure 9.c: *The modeling of the observation 4 green bean vegetable farm.*

The graph (Figure 9.c) illustrates the effects temperature to the number of insects and the percentage of insect smortality and insect reproduction in Green bean vegetable farm.

Overall, the quantity of insects and the percentage of insect mortality and insect reproduction significantly decrease for few first days and slightly reduce to the lowest poit at 0 at the first half period of experiment with the same temperature of 34 Celsius degree. To specific, the number of insects falldown quickly for the first two days from 21to 2 before decrease to sink to a low of 0, there was the same with the downward trend in the percentage of insects mortality. In the same way, the proportion of insect

reproduction slightly decrease until the bottom of 0 at the day of nine while the temperature stay unchanged at 35 Celsius degree. Interestingly, all the number of insects and insects mortality went down in the same trend and same quantily and percentage together to the lowest point.



Time \ Name	temperature	number of insects	insects reproduction	insects mortality
0	[illegible]	31.0000	0.9300	16.2750
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	11.2306	0.3369	5.8961
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	4.0686	[illegible]	2.1360
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	1.4740	[illegible]	0.7738
7	[illegible]	[illegible]	[illegible]	0.4650
8	[illegible]	0.5340	0.0160	0.2803
9	[illegible]	[illegible]	[illegible]	0.1687
10	[illegible]	0.1935	0.0058	[illegible]
11	[illegible]	0.1164	0.0035	[illegible]
12	[illegible]	0.0701	0.0021	0.0368
13	[illegible]	0.0422	0.0013	0.0221
14	[illegible]	0.0254	0.0008	[illegible]
15	[illegible]	0.0153	0.0005	0.0080
16	[illegible]	0.0092	[illegible]	0.0048
17	[illegible]	0.0055	0.0002	0.0029
18	[illegible]	[illegible]	0.0001	[illegible]
19	[illegible]	0.0020	0.0001	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	0.0007	2.2e-005	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	0.0003	7.9e-006	0.0001
24	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	0.0001	2.9e-006	0.0001

Figure 9.d: *The modeling of the observation 4 chili vegetable farm.*

The graph (Figure 9.d) demonstrates how the temperature and the quantity of insect and the proportion of insect's mortality and insect's reproduction changed in chili vegetable farm in 25 days of experienced

Overall, the number of insects and the percentage of insect reproduction and insect mortality fall down significant at most of period before decrease slowly to hit a low of 0 at few last days of 25 days experiment when the temperatur stay unchanged at 21 Celsius degree. To be specific, there was a pluge in the number of insects from 31 to 4 for the fist four day, followed by the slight decrease from 4 to 0 at the last day in 25 days of experienced. Likewise, there was a continous decline in the porportion of insect mortality from 16.2 to 0 at the day of twenty five one at the same constant of 24 Celsius degree.

Strikingly feature , the proportion of insect reproduction decreased slightly with downward trend to hit a low of 0 in the day of nineteen while there was only the number of insect and the rate of insect mortality come to hit a low at the last day in 25 day experienced.

PART V: DICUSSIONS AND CONCLUSIONS

5.1 Discussions

5.1.1 Restrictions/ Limiting Conditions

Because it is a scienctific research, beside the positive aspects, there were also many negative aspects, restrictions and also the limitting conditions from the beginning to the end of the progress. The first to mention about the difficult to find the location, each location should be located in far differences in geographic location with differences kind of vegetables, when the location was found, there were not allowed to do the observation, there would be some negative affected to their farms and also the agricultural productivity. When the owner allowed, but the condition of the field did not meet the requirements of the study the farmer use chemical compounds or pesticides in order to get the best benefit from the produce. Secondly, the conditions required fields must be separated, there could not be collected or did the observation at the same time, most of the insects on the fields were the insects which had predatory lifestyle and keen fly during the day as dragonflies, flies, mantis, bees, butterflies and beetles usually slow and less active in the early morning but more active when the duration come to mid - noon.

Other insects prefer dark at night and activities (like cockroaches), with cramped living under the deep trench in the ground such as ants and termites often more difficult to find and collect. All the present of the fly insects and also soil insect should be collected, thus the result would not be exactly as what we expected, having to do the observation in different day was the method that decided,it could not be in the same day so it may impact to the result of the research.

5.1.2 Increased temperature could increase pest insect population

This research paper has clearly shown and agreed that warmer temperature will result in more types and higher population of insects, increasing temperature could increase pest insect populations throught the effecting to insect survival, development, geographic range, and population size, throught the directly and indirectly of the physiology or existenc of hosts, temperature can impact physiology and development of insects. Insects have shorter life cycle if the temperature is higher, tell in other word, the number of insects significant decrease when the temperature at higher constant.

5.1.3 Increased temperature could also decrease pest insect population

The theory of insect's population led us to infer that warmer temperature events may lead to an increased number of insects of potential economic significance in the system of agriculture. Furthermore, environment change will directly effect on insects, and there may lead to phonological shifts between herbivore and host and predator and host. The insects will earlier mature if the effects of warmer temperature on their age structure.

However, go against the theory, there will be some differences, warmer regions do not always have much more insect population and insect species. Human activities are also causing the change in population of insect.

In some case, perhaps the result of this research could be argued that increased tempreature could also decrease piest insect population (In Green Bean). Some insects are closely tied to a specific of host crops (Pea and Bean Weevils, Maggot), temperature increase that cause farmers do not grow the crop more, the farmers do not care and harvest the production, because there is likely to no capacity, it would be decrease the population of insects pets in that crops. The factors that impact pest insects may impact to their insect predator and parasites as well as the the disease that infect the pests. It is result in increased attack on insect populations.

5.1.4 The relationship between temperature and insects

This study has taken a step in the direction of defining the relationship between temperatures, weather and insects population, it is possible that other factors may also produce entirely different result. In addition, it is important to emphasize that methodological problems in the research design limit our interpretations. Insects are cold-blooded organisms, the temperature of their bodies is similar or approximately that same as environment, so the temperature is the most important environment factors influence insect behavior, distribution, development, survival reproduction and mortality,

5.2 Conclusions

From the research that has been carried out, we can conclude that effect of environmental change is more in temperate insects, it permits the expansion range,

temperature is important force to drive the population, survival, growth and development are caused by the direct effects of temperature. There are several complex way the impact of increasing temperature to crop pest population. Althought some climate change temperature effects might tend to depress insect population.

This research paper has clearly shown and agreed that warmer temperature will result in more types and higher population of insects, increasing temperature could increase pest insect populations throught the effecting to insect survival, development, geographic range, and population size, throught the directly and indirectly of the physiology or existenc of hosts, temperature can impact physiology and development of insects. Insects have shorter life cycle if the temperature is higher, tell in other word, the number of insects significant decrease when the temperature at higher constant.

It has also shown that with suitable temparatures, the insects develop more rapidly, by using the degree-day, using the models to predict the emergence of these insects and their potential to damage crops.

Insects are cold-blooded organisms, the temperature of their bodies is similar or approximately that same as environment, so the temperature is the most important environment factors influence insect behavior, distribution, development, survival reproduction and mortality,

The insect may be the possiblity of evolutionary adaptation for changing the environment. Therefore, climate change might change the insect population dynamic of insect pests differently in

It may be time for more attention to unsderstand and handle these issue throught conducting more research. In order to validate the work we have carried our, a more in-depth investigation more the systematic documentation of major as well as minor pests, developing prediction models like Simile Models and studying more evolutionary changes under modified the environment are needed. Thus it would be useful to face the challenge in near future.

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APPENDICES

Appendix 1: The insect biodiversity in the study area at the observation 1.

Name of Insects / Farms	Sangkuriang, Sako (Eggplant)	Kenten Ashar (Cumcumber)	Kenten Sukamaju (Green Bean)	Indralaya (Chili)
Acanthosomatids	100	400	600	400
Aeshnidae Hawkers	2	0	0	2
Ants	1000	800	800	1200
Blattidae	1	0	0	0
Brown Leafhoppers	300	0	0	0
Burrowing Bug	150	0	0	0
Bush Crickets	0	0	0	10
Carpenter Bees	0	0	0	2
Club-tailed Dragonflies	1	0	1	2
Common Wasps	30	0	0	0
Corn earworm	0	0	0	0
Crane flies	800	0	0	0
Darking Beetles	90	0	0	0
Eurytomids	0	0	20	0

Flesh Flies	0	20	10	20
Flower wasps	1	3	2	4
Grasshoppers	60	0	0	0
Green vegetable bugs	45	80	30	0
Ground beetles	0	0	0	100
Honey Bees	10	10	8	5
Ladybirds	450	200	200	400
Larva Ground beetle	0	0	0	40
Larva ladybirds	900	100	200	800
Larvae Scarab Beetls	0	0	20	0
Leaf beetles	0	0	10	0
Leaf-footed bugs	0	400	0	200
Leafhoppers	0	0	0	10
Litter house Flies	90	10	0	10
Locust	45	20	40	10
Locust	30	0	0	0
Mole Cricket	2	0	5	0
Mosquitoes	900	500	800	400
Narrow-winged Damselfly	2	0	0	1
Northern Caddisflies	0	0	0	0
Pea and Bean Weevils	0	300	100	100
Plant Bugs	15	0	0	10
Potter waps	8	10	0	0
Praying mantid	0	0	3	0
Red Leafhoppers	90	0	0	0
Rove beetles	3	0	0	0
Sand Wasps	0	0	0	10
Scarab Beetles	0	0	0	20
Scarab Beetles	300	0	0	100
Scelionid Wasps	15	0	0	0

Scentless Plant Bugs	15	160	40	0
Seed bugs	0	0	20	20
Shield bugs	15	0	0	0
Slipe flies	0	40	0	0
Squash bug	900	100	100	400
Stink bug	90	40	0	50
Thick headed flies	0	5	10	0
True Cricket	4	0	3	0
Weevils.	200	0	0	300

Appendix 2: The insects biodiversity in the study area at the observation 2.

Name of Insects Farms	Sangkuriang , Sako (Eggplant)	Kenten Ashar (Cumcumbe r)	Kenten Sukamaju (Green Bean)	Indrala ya (Chili)
Acanthosomatids	200	1000	1200	500
Aeshnidae Hawkers	1	0	0	1
Ants	1000	1500	1500	2000
Black Flies	0	0	0	20
Brown Leafhoppers	200	0	0	0
Burrowing Bug	150	0	0	0
Bush Crickets	0	0	0	0
Camponotus compressus	0	100	0	0
Cardinal Beetles	200	0	0	0
Carpenter Bees	0	0	0	2
Carrion Beetle	40	0	0	0
Club-tailed Dragonflies	2	0	2	4
Common Wasps	0	0	0	2
Corn earworm	0	0	80	0
Crane flies	1500	0	0	1
Cuckoo	3	10	20	0
Darking Beetles	90	0	0	0
Dor beetles	0	0	0	0
Earwig	0	0	20	0

Eurytomids	0	0	20	0
Flesh Flies	3	10	20	0
Flower wasps	0	0	2	0
Grasshopper	30	10	10	20
Green jewel bug	30	0	0	0
Green vegetable bugs	180	20	80	0
Ground beetles	300	0	0	100
Honey bees	10	10	8	8
Ladybirds	600	100	200	300
Larva Ground beetle	0	0	0	100
Larva ladybirds	100	50	100	200
Larvae scarab beetles	0	0	100	20
Leaf beetles	150	0	0	10
Leaf-footed bugs	0	160	20	10
Leafhoppers	100	80	0	20
Litter house Flies	40	10	0	40
Locusts	60	10	40	10
Long-horned grasshopper	45	200	0	400
Mosquitoes	1200	800	1200	500
Narrow-winged Damselfly	2	2	1	1
Northern Caddisflies	2	0	1	0
Pea and Bean Weevils	0	300	150	80
Plant Bugs	30	0	10	20
Plant Lice, Greenfly	0	0	0	200
Potter waps	15	10	0	0
Red Leafhoppers	60	0	0	10
Rove beetles	0	0	0	100
Sand Wasps	0	0	0	10
Scarab Beetles and Chafers	200	0	0	100
Scelionid Wasps	10	0	0	2
Scentless plant Bugs	15	40	20	0
Seed bugs	0	0	0	30
Shield bugs	10	40	150	100
Slipe flies	90	80	0	0
Subterranean	0	0	0	10
Squash bug	900	100	100	800
Stink bug	90	50	0	20
Subterranean	0	0	0	0

Thick headed flies	0	10	10	0
True Cricket	0	0	3	0
Weaver ants	0	800	0	200
Weevils	200	0	0	400

Appendix 3: The insects biodiversity in the study area at the observation 3.

Farm / Name of Insects	Sangkuriang, Sako (Eggplant)	Kenten Ashar (Cumcumbe r)	Kenten Sukamaju (Green Bean)	Indralay a (Chili)
Acanthosomatids (Rệp lá)	**300**	1000	1000	800
Ants	1500	1200	800	1500
Black Flies	0	0	0	20
Blattidae	2	0	0	0
Brown Leafhoppers	150	100	0	0
Brown planthopper	0	0	0	0
Burrowing Bug	150	0	0	0
Bush crickets	0	0	10	0
Butterflies	2	2	1	0
Cabbage shield bug	0	100	0	0
Camponotus compressus	0	200	0	800
Cardinal Beetles	20	0	0	0
Carpenter Bees	6	0	0	6
Carrion Beetle	40	0	80	0
Club-tailed Dragonflies	2	0	1	1
Common Wasps	15	0	0	0
Corn earworm	0	0	10	0
Crane flies	1000	0	0	0

Cuckoo	20	10	10	20
Damsel Bug	30	0	0	0
Darking Beetles	90	0	0	0
Flesh Flies	10	0	10	10
Flower wasps	0	0	10	0
Grasshoppers	20	20	0	0
Green jewel bug	30	20	0	0
Green vegetable bugs	20	0	0	20
Ground beetles	0	0	0	40
Honey Bees	8	4	4	6
Ladybirds	200	200	100	300
Larva ladybirds	100	50	100	300
Larvae Scarab Beetls	30	0	20	0
Leaf beetles	30	20	50	0
Leafhoppers	90	0	0	10
Litter house Flies	30	10	0	10
Locusts	30	0	0	0
Longhorn Beetles	30	0	0	0
Long-horned grasshopper	10		0	0
Maggot	500	100	0	0
Mole Cricket	0	0	0	0
Mosquitoes	1200	1000	800	1000
Nabid nymph	0	40	0	0
Narrow-winged Damselfly	2	1	1	2
Northern Caddisflies	0	0	2	
Pea and Bean Weevils	0	200	80	200
Plant Bugs	30	0	0	0
Potter waps	10	0	3	1
Praying mantid	0	1	2	0
Red Leafhoppers	10	0	0	0
Rove beetles	0	0	0	0
Sand Wasps	0	0	0	10
Scarab Beetles and Chafers	150	0	0	5
Scelionid Wasps	10	0	0	10
Scentless Plant Bugs	10	0	0	0
Shield bugs	10	0	0	0
Sitophilus	0	0	0	200
Slipe flies	0	20	0	0
Snipe Flies	0	40	0	0
Squash bug	900	0	0	20

Stilt Bug	90	30	0	0
Stink bug	0	0	80	20
Subterranean	0	0	0	5
Thick-headed Flies	0	0	0	6
Tress damsel bug	0	20	0	0
True Cricket (Cricket)	0	0	2	1
Water Scavenger Beetles	0	0	10	0
Weaver ants	0	20	0	0
Weevils	300	0	0	0

Appendix 4: The insects biodiversity in the study area at the observation 4.

Name of insects / Farm	**Sangkuriang, Sako (Eggplant)**	**Kenten Ashar (Cumcumber)**	**Kenten Sukamaju (Green Bean)**	**Indralaya (Chili)**
Aeshnidae Hawkers	1	2	2	4
Ants	1500	1000	1500	2000
Black Flies	0	0	0	2
Brown Leafhoppers	120	20	0	0
Brown planthopper	0	0	0	0
Burrowing Bug	120	0	0	0
Bush crickets	0	0	5	0
Butterflies	2	2	1	0
Cabbage shield bug	0	60	0	80
Camponotus compressus	0	0	0	1000
Carpenter Bees	0	0	0	10
Carrion Beetle	30	0	60	0
Club-tailed Dragonflies	3	0	0	1
Common Wasps	4	0	5	0
Corn earworm	0	0	10	0
Crane flies	100	0	0	0
Cuckoo	2	0	20	20
Damsel Bug	30	0	0	0
Darking Beetles	60	0	0	0

Dor beetles	5	0	0	10
Flesh Flies	0	0	10	20
Flower wasps	0	0	0	20
Grasshoppers	20	0	0	40
Green jewel bug	30	10	0	30
Green vegetable bug.	20	10	0	30
Honey Bees	5	10	8	10
Ladybirds	150	100	150	300
Larva ladybirds	100	150	100	300
Leaf Beetles	60	10	40	0
Leafhoppers	80	0	0	20
Litter house Flies	20	15	0	20
Locusts	30	0	0	0
Longhorn Beetles	20	0	0	0
Long-horned grasshoppe	5	0	0	0
Maggot	800	500	150	50
Mole Cricket	0	0	0	0
Mosquitoes	1200	1000	1000	800
Nabid nymph	0	10	0	0
Narrow-winged Damselfly	2	0	0	2
Northern Caddisflies	1	0	8	0
Pea and Bean Weevils	0	100	100	200
Plant Bugs	30	0	0	0
Plant Lice, Greenfly	0	0	0	30
Potter waps	5	0	0	0
Praying mantid	0	0	2	0
Red Leafhoppers	10	0	0	0
Rove beetles	2	0	0	0
Sand Wasps	5	0	0	5
Scarab Beetles	120	0	0	0
Scelionid Wasps	10	0	0	10
Scentless Plant Bugs	8	0	0	0
Shield bugs	10	0	0	0
Sitophilus	0	0	0	200
Slipe flies	0	10	0	0
Snipe Flies	0	20	0	0
Squash bug	900	0	0	20
Stilt Bug	90	0	60	20
Stink bug	20	0	0	20
Subterranean	0	0	0	0

Thick-headed Flies	0	0	0	0
Tree damsel bug	0	10	0	0
True Cricket (Cricket)	0	0	2	0
Water Scavenger Beetles	0	0	5	0
Weevils	300	0	0	5

SOME PICTURES DURING MY RESEARCH TIME AT UNIVERSITY OF SRIWIJAYA, PALEMBANG, SOUTH SUMATERA, INDONEISA

Appendix 5.a Eggplant vegetable farm

Appendix 5.b Cucumber vegetable farm

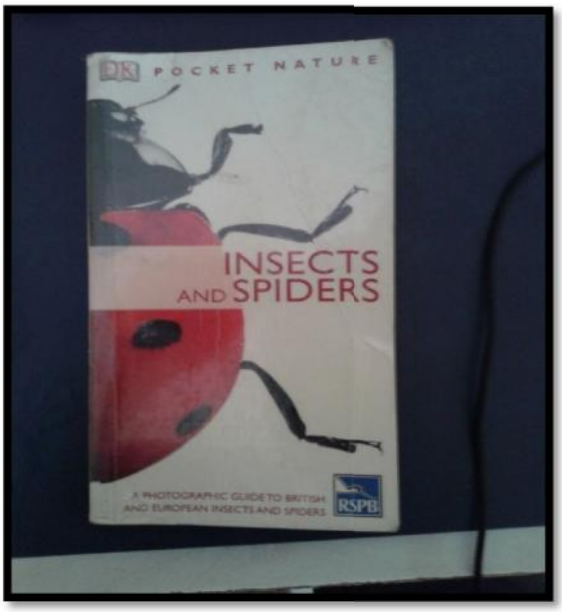
Appendix 5.c: Green Bean vegetable farm **Appendix 5.d:** Chili vegetable farm

Appendix 6.a: Flooding Square

Appendix 6.b: Insect nets

Appendix 7.a:*Containers*

Appendix 7.b *Alcohol*



Appendix 8.a *Microscope*

Appendix 8.b *Insects identification book*

Appendix 9.a. Working at Pesticide Toxicology Laboratory

Appendix 10: *conducting my research with other research group who is supervised by Dr.-phil. ARINAFRIL to collect all the insects in the study area.*