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Solar Energy-Based Insect Pest Trap

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Abstract

Agriculture is the main occupation of Thai people. Farmers encounter the problems of various types of insect pests that harm crops and result in loss of productivity each year. Therefore, it is necessary for farmers to use pesticides to prevent crop damage. However, when pesticides are used in large quantity, they cause adverse impacts on people, animals and the environment. Instead of using pesticides, the government has to support other ways to prevent insect pests, including the use of biological agents and some insects etc. A previous study has shown that the ultraviolet light of light emitting diode tube could be used to lure "Coconut Hispine Beetle"(Plesispa reichei Chapuis), a damaging pest of coconut and a range of palm species. This study aimed to develop Solar Energy-Based Insect Pests Trap by using ultraviolet light emitting diode tube to lure the insect pests and 12 volt battery as power supply to light emitting diode tube. The battery charging system derives electrical energy from 20 watts of solar cell for use at night. This proposed Solar Energy-Based Insect Pests Trap has an automatic control system to lure insect pests when there is no sunlight and the system will be stop when the sun shines. The results of the system installation test showed that this proposed Solar Energy-Based Insect Pests Trap could lure several types of insect pests in vegetable and coconut plantations including Brotispa, Elephus beetles, and Aphis, etc.

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Keywords: Solar Energy-Based; Solar cell; Insect Pests Trap

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1. Introduction

Agriculture is a principal occupation in Thailand. Every year farmers face pest problems which seriously destroy crops. There are many preventions and exterminations of pest problems, such as mechanical method, physical method, biological method, and chemical method. Using pesticides and chemical method directly affects on agriculturists and consumers, for example, pests are chemical resistant which leads farmers using more and more pesticides. This causes plant residue which is dangerous for consumers, and also affects on environment and ecology.

At present, the consumers emphasize on safe and non-chemical food. The producers should be aware of this matter and reduce pesticide to decrease farmers' and consumer's health problems by creating non-chemical and pesticide measures. Moreover, agriculturalists has tried to find other ways instead of chemical used such as using lights to tempt pests which is popular way for farmers. However, that way is still lack of electric energy for bulbs because the farm is far away, and trap is also expensive. From this point, the researcher has developed Solar Energy-Based Insect Pest Trap for orchards and vegetable.

2. Objective

To develop Solar Energy-Based Insect Pest Trap

3. Insect and pest control

Nowadays there are many ways to destroy insect and reduce damages from pest. Besides, there are pests in exported products that affect on export value and setting price of agricultural products. Insect and pest control is necessary for agriculturists to solve the problem. Farmers use many ways with insects and pests such as,

1) Biological Control or Biocontrol. This method is using pests' natural killers to destroy and control the outbreaks. For example, farmers used Chelisoches morio (Fabricius) and Krigrogramma waspto control and destroyed Brontispa longissima Gestrowhich ruined top of coconut trees. Farmers also maintained good environment for pest killers to live and propagate. This method is widely used to control Pultella xylostella, Trichoplusia ni, Spodopterasp, Heliothis armigera, and Leaf rolling centerpillar. The natural pest killers are Rove beetle, Parasite, Pthogen, fungi, Entomogenous nematode, etc.

2) Plant Resistance. This method is using Pest-Resistant Crop Variety planted appropriately in farm. The plants are improved to prevent pest from breeding and genetic engineering. After improvement, the plants are called Transgenic Crop Plants. Nowadays the TCP are corn, potato, bean, tomato, cotton, tobacco, rice, wheat, etc. We call products from TCP as Genetically Modified Organisms; GMOs. In Thailand, the improved plant resistances are rice, cane, and sesame.

3) Cultural Methods. This method can control only one group of pest in a time. Such as cultivating the least pest plant, using transplantation instead of seeding, choosing mulching materials, intercropping, and crop rotation to cut pest's life circle.

4) Mechanical and Physical Methods. This method controls the important pests in every group by using light, radiation, sound, heating techniques and machines to control and prevent pest; this method requires hi-technology which is expensive. For example a) Using nylon net covers vegetable bed to protect moth laying eggs on leaves. The nylon net can prevent Pultella xylostella, Armyworm, and Caterpillar. The disadvantage of nylon net is that it will be destroyed from wind blowing or windy storm in open area where is no wind bread. b) Using sticky yellow-enameled pest trap. Insects usually fly to yellow materials. We cover the stuffs with sticky material and hang them on stakes a little bit, above from plants about 1 meter from the ground. The materials can be gasoline gallon, plastic bucket, plastic board, wood, or galvanized iron sheet which are a square foot and are hung every 3 square meters of plant plot's space. The insects were trapped are Phylum arthropoda, Armyworm moth, Pultella xylostella moth, Fruit fly, Whitefly, Fire leafhopper, Cicada leafhopper, and Aphid. c) Using black light trap. Agriculturists usually use ultraviolet fluorescence bulb or black light bulb to trap Giant water bug. The agricultural researchers use light to trap insects for collecting data about insect demographic for decreasing damageable plantation. They support farmers to use bulb in orchards. For example, set 20 watts black light bulbs by hanging them 40 centimeters above

cement pipe edges with every 50 meters long. The diameter is 1 meter. Then fill the pipes with detergent water, kerosene, or diesel to trap insects. There are many insects were trapped by this method such as Heliothis armigera, Spodopterasp, Nilaparvata lugens, Agrotisp, Nephotettix nigropictrs, Scotinopharasp, Orseolia oryzae, etc (Latbualuang Agriculture Extension Office, 2014).

5) Legal Control. Using prevented principles via Acts. Thailand has the Plants Quarantine Act B.E. 2507, the purposes are 1) Prevent any pests from abroad, and 2) Prevent specific pests from any regions to spread to other areas.

6) Chemical Control. Using pesticides or agropesticides or any chemical with some type or groups of pets, but the stuffs may also affect on many types or groups. There are many pesticides for effectively pest control. Nowadays the botanical pesticides are quite safe for both injectors and consumers; such as natural Neem extracts.

7) Integrated Pest Control. It is using more than 2 methods of previous control together. This method is developed to IPM (Integrated Pest Management) which is pests control to reduce chemical and increase environmental safety.

8) Natural or Organic Farming. There is no direct pest control, but using environmental relation understanding on various living things. This emphasizes producing processes more than products (Tavatchai, 2014).

4. Research methodology

The Solar Energy-Based Insect Pest Trap research is an experimental research. The purpose is, to produce and invent Solar Energy-Based Insect Pest Trap by using ultraviolet LED bulbs as light source. The ultraviolet is effective wavelength to tempt insects. Solar cells are used to change solar energy to electric energy and change to battery for pest trap. After that, bring the trap to test the effectiveness and results of pest trap in agricultural areas. The processes are;

1. Design. The concept idea of Solar Energy-Based Insect Pest Trap design is using general stuffs; electronic mosquito trap, acrylic boards. The trap has to easily produce, not complicate for teaching to agriculturalist. The Solar Energy-Based Insect Pest Trap consists of a) 20 watts Solar cell to change solar energy to electric energy for battery charging. b) 12 volt 14 Ah Sealed Lead Acid Calcium battery to save electric charge in daytime and give electric energy to LEDs at nighttime. c) Ultraviolet LED. They have 315-400 nm for wavelength; the most appropriate wavelength for insect tempting (Nichanun, Chanonpat, 2014; Taiwan Agricultural Research Institute, 2014). d) Light sensor switch circuit, it is on/off switch for LED. If the sensor gets lights from solar energy, it does not work yet. If the sun sets or the sensor cannot get any lights, the switch works by transfer electric energy from battery to LED. The LED bulbs will on at nighttime. e) Electronic mosquito trap is used to shock insects which fly to LED.

2. Invention. The main structure of Solar Energy-Based Insect Pest Trap is made from steel for durable using in agricultural fields. Its height is 150 centimeters. On the top of Insect Pest Trap, install the 20 watts solar cells panel, size 45x45 cm, 10-15 degrees of elevation angle for solar effective. The base of the trap is steel plates to mount the ground. The insects tempt consists of 30x40x15 (width x length x thickness) clear acrylic square box which can let LED light out of the box. There is wire mesh of electronic mosquito trap on one side of the box. There are 150 LED size 7x7 mm; 5 rows of 30 LED bulbs each inside the box. Other stuffs are 5 amps battery charger, 12 V 14 Ah Sealed Lead Acid Calcium battery, light sensor switch circuit, and high voltage circuit of mosquito trap are set in steel box to prevent from any damages, as shown in Figure 1.

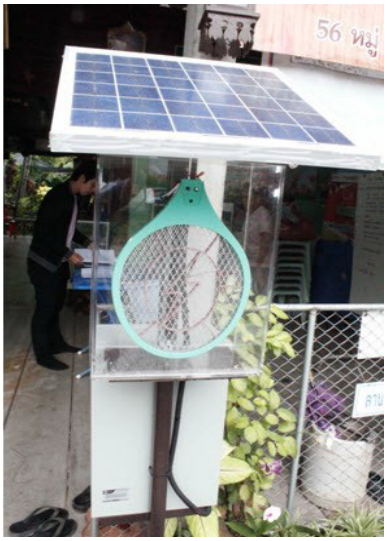

Fig. 1 Solar Energy-Based Insect Pest Trap

3. Effectiveness test and result. The technical effectiveness of Solar Energy-Based Insect Pest Trap are; LED illumination, the amount of current supply to LED, the amount of current used to charge battery, and duration time of battery used. The measuring instruments are volt meter, ampmeter, and luxmeter. The test is produced by set the trap in agricultural fields to find what types of insect and pest can be trapped , as shown in Figure 2.

a b

Fig. 2a-b Solar Energy-Based Insect Pest Trap install in agricultural fields

5. Results

1. The result on illuminated effectiveness of LED shown that, the 150 LED bulbs produced 160 luxs at 0.5 meters and 25 luxs at 2 meters.

2. The result on the amount of current supply to LED found that, the current supply was 1.1 amps; 13.2 watts, when connected 12 volts battery to 150 LED bulbs.

3. The result on the amount of current used to charge battery found that, the voltage at 11 am – 1 pm which the solar cells got the most solar energy was 17 volt. When connected solar cells to battery charger, the current 1.2 amps was transferred to battery.

4. The result on using electric energy from battery since battery was fully charged shown that, LED was light for 7-8 hours at 60% of discharge current. That duration was enough to light LED at nighttime for insect trapping.

5. The result of light sensor switch circuit test indicated that, when there was no sunlight on sensor, the sensors worked properly 100%. The sensitivity to light could be changed depends on the area. Moreover, we could set working time for 1-12 hours for the best insect trapped time. When there was sunlight on sensor, the switch also could work properly 100%.

6. The result of insect and pest trapping found that, Cocinellidae, Cicada leafhopper, Adult cotton leaf worm, and Leaf minor fly were trapped in orchard. The Rhinoceros beetle and Brontispa longissima Gestro were trapped in coconut farm, as shown in Figure 3.

Fig. 3 Insect and pest trapped in Solar Energy-Based Insect Pest Trap

6. Conclusion and Suggestion

1. This solar energy-based insect pest trap research chose general materials to be adapted for pest trapping such as electronic mosquito trap and clear acrylic board. Then simple design was created for easily teach to farmers.

2. The Solar Energy-Based Insect Pest Trap can trap many pests such as Cocinellidae, Nephotettix nigropictrs, Adult cotton leaf worm, Leaf minor fly, Rhinoceros beetle, and Brontispa longissima Gestro. They are general pests in farm around Thailand but small number can be destroyed because there was only one side of wire mesh.

3. LED bulbs with 12 volts were safer to use more than fluorescent bulbs with 220 volts. If the electrical short or leakage current were happened, the users would not get seriously hurt.

4. This trap did not appropriate for tall and leafy trees because the sunlight could not shine on the trap, the solar cells could not produce electric energy to battery.

5. The trap should be improved for lighter scattering as 360 degrees from the trap. The ways into LED should be provide more for more insects and effectively trap.

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