APPLICATION OF AUTOMATION AND ELECTRONICS IN MAKING THE TRAPS TO CATCH HARMFUL INSECTS

Pham Duc Long
TNU - Information and Communication Technology University

ABSTRACT

In this paper we present the results of original research in applying electronic - automation techniques to create traps to catch and kill harmful insects. The techniques base on living habit of some Insect Pests of Tea. The traps are supplied by solar energy. These traps can also be used to catch several other kinds of harmful insects such as mosquitoes, flies. The products worked well in practice when it was tested to catch some harmful insects.

Keyword: *Insect Pests of Tea; harmful insects; Insect trap; attract Insect; Insect Trap Patents.*

Received: 28/5/2019; Revised: 04/6/2019; Published: 06/6 /2019

ỨNG DỤNG KỸ THUẬT ĐIỆN TỬ - TỰ ĐỘNG HÓA CHẾ TẠO BẪY DIỆT CÔN TRÙNG CÓ HẠI

Phạm Đức Long
Trường Đại học Công nghệ Thông tin và Truyền thông – ĐH Thái Nguyên

TÓM TẮT

Trong bài báo này chúng tôi trình bày các kết quả nghiên cứu ban đầu ứng dụng các kỹ thuật điện tử - tự động hóa để tạo ra các bẫy diệt côn trùng có hại dùng năng lượng mặt trời dựa trên tập tục sinh hoạt của một số loại côn trùng hại chè phổ biến. Các bẫy này cũng có thể sử dụng được để bắt một số loại côn trùng có hại khác như muỗi, ruồi. Sản phẩm đã hoạt động tốt trong thực tế khi được thử nghiệm bắt một số côn trùng có hại.

Từ khóa: *Insect Pests of Tea; harmful insects; Insect trap; attract Insect; Insect Trap Patents.*

Ngày nhận bài: 28/5/2019; Ngày hoàn thiện: 04/6/2019; Ngày đăng: 06/6/2019

Email: pdlong@ictu.edu.vn

https://doi.org/10.34238/tnu-jst.2019.10.1601

1. Tea plant and harmful insects

1.1. Tea plant and economic importance

Tea tree is an industrial plant played an important role in Vietnamese agriculture [1]. In Vietnam, there are many tea growing areas in Thai Nguyen, Lam Dong and Phu Tho provinces,… Income from tea products is large in these provinces. For example, Thai Nguyen is one of the top provinces in Vietnam in class cultivated area, quantity and quality of tea products. Thai Nguyen tea, especially Tan Cuong tea, is a famous product in Vietnam for a long time. Thai Nguyen province currently has over 21,000 ha of tea plant; in which over 80% of tea area in concentrated production areas is produced in a safe manner, applying good agricultural production process; 80% of tea production in Thai Nguyen province is processed by traditional methods, mechanized by Green tea leaf drying Machine and small-scale processing lines at 43 cooperatives and over 60,000 households in 140 tea craft villages manufacturing. Thai Nguyen tea products are mainly green tea and high quality green tea. Income from tea products in Thai Nguyen has averaged over 5000 US$ / ha / year [2]. Currently, Thai Nguyen province is implementing the project to increase the value of income from tea products, to sustainably develop tea trees with the total investment capital expected to be over 10 million US$ by 2020. In order to ensure safety standards for tea products to domestic use and export, one of the most important problem of the research is invented non-chemical methods to kill tea harmful insects. The research and experimental results on tea plants and tea insects and pests in Thainguyen in this paper are also meaningful and can be applied to other tea growing areas in Vietnam.

1.2. Several types of worms and insects that harm tea

There are many popular types of worms and insects that harm tea [3]: *Empoasca flavescens, Helopelthis theivora Waterh, Physothrips setiventris Bagn, Oligonychus coffeae Niet, Toxoptera aurantii, Homona coffearia Niet, Euprotis pseudoconspersa Strand, Arbela dea Swinh, Agriophora rhombata Meyr*.

Figure 1. *Four popular types of tea harmful insects, pests*

*** Empoasca flavescens life cycle, live habit:** Science name: *Empoasca flavescens*. They are insects that cause great harm to tea in Vietnam. With newly planted tea, especially tea under 4 - 5 months old they can cause tea buds to dry, make tea trees grow slowly and stunted even can kill trees. With bigger tea trees are less damage. *Empoasca flavescens* are strong growth in cool conditions, high air humidity. In Thai Nguyen *Empoasca flavescens* are born and cause much harm in the months of May to December. Life cycle of *Empoasca flavescens* for about 14 - 21 days. Egg Time (5-8 days). Young children (9-11 days (spring time), 7-8 days (summer time), 14-16 days (winter time). Mature and juveniles *Empoasca flavescens* are do not like sunlight so daytime they hide under the leaves. They often move horizontally, if there are noises or unnormalities, they jump out of their standing. *They are attracted to weak light.*

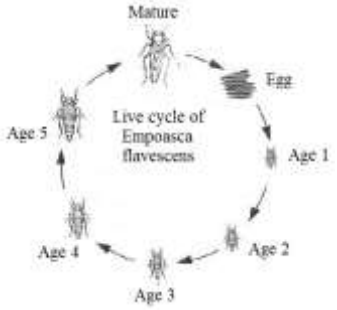
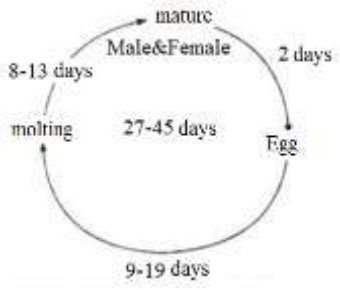


Figure 2. *Live cycle of Empoasca flavescens*

*** Helopelthis theivora Waterh (**acronym: ***Helopelthis*****)**. Helopelthis is also a popular harm tea insects. Their life cycle is shown in Figure 3.



Figurre 3. *Live cycle of Helopelthis*

They cause much harm to tea during rainy, wet seasons. They harm strong to tea tree in the early morning and afternoon. *Adult and also Juveniles Helopelthis often pretend to die when there is danger. They fell to the ground like death and escaped*.

*** Physothrips setiventris Bagn (**acronym: *Physothrips****)*** **life cycle, live habit:** *Physothrips* live cycle in Figure 4.

+ *Physothrips* often thrive in hot, dry weather, each year they damage two main periods: Period 1: from April to August, this time the tea is growing new leaves so tea tree is serious damage. Period 2: From mid-October to the end of November, this period is small harmful and usually in a narrow area.

+ A very noticeable feature for *Physothrips* is that they often fly high above the field at dusk (type "tornado") so they can spread quite far in the field by wind.

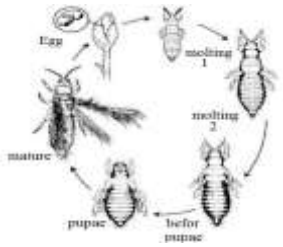


Figure 4. *Live cycle of Physothrips*

*** Oligonychus coffeae Niet:** They are also one of the major pests for tea trees; eEspecially when the weather is sunny. Traps studied and designed in Part III of this paper have little effect on Oligonychus coffeae Niet so here we do not describe them in detail.

2. The curent methods to kill harmful tea insect and worm

2.1. Mechanical method (use hands, rackets, sucking machine)

This classic method is often used by humans since ancient times. Using their hands to scratch the soil, find by eye, catch and kill by hand. This method could not be satisfied with the large field of cultivation when there is a small density of insects and worm also even more difficult to implement when the density of insects and worm is large. There has been some improvement idea of using machine to sucking insect and worm, but so far these improvements have not reached good results and use is not very convenient. This is also a tend that needs further to more research.

(a) (b) (c)

Figure 5. *Catch by hand (a, b) and use machine to sucking insects and worm (c)*

2.2. Use chemicals

This is a popular method currently used to kill insects, worm of all kinds in agriculture. This method is recommended reduced apply in practice because it gives many bad impacts to environment and people; Prescribing residues of plant protection substances such as Fipronil, Acetamiprip, Imidacloprid, Carbendazim, Cypermethrin and Buprofezin currently allow very little in tea products. For example, under international regulations, the ingredient of fipronil for tea products is at 0.002 ppm (milligrams / 1 kg of tea – ie 1 part per million - almost equal to 0).

2.3. Use electromagnetic wave energy

There are many types of electromagnetic waves with certain characteristics capable of destroying living cells. For example: High-power ultrasound can destroy small worm. Thus, it is possible to use large-power electromagnetic waves to kill harmful insects. However, the method has the disadvantage of needing large power and when perform, it will kill also other insects; including useful type. Therefore, the current research trend on the effect of electromagnetic waves on insects is either ***attracting*** or ***repelling*** because in these two trends the power of wave source does not need to be large.

2.4. Use biological method:

Content of this method is: Develop number of natural enemies of harmful insects. This method has now been applied but not yet popular.

3. Design and make trap to kill harmful insects

Through the survey of living behavior, the life cycle of tea pests in the above parts of this paper, we see that after hatching from eggs, these insects all have flight stages and have properties attracted by low light [4], [5], [6], [7]. We can use properties attracted by low light and use some characteristic flavor to attract insects to catch and kill. The research of electromagnetic wave characteristics as in [8], [9] to attract insects that has not been perform within this paper.

3.1. Objective

The main objectives of the design and make trap to experiments that is presented in this paper is:

+ Multi objective and Attract insects to catch and kill: Designed traps can capture three types of insects *Empoasca, Helopelthis, and Physothrips*. In addition, when using aromatics flavor, it is possible to catch also mosquitoes and flies.

+ Low cost and high durability: This objective will satisfied with the users of this type of this tool, who are farmers and places of use are outdoors. Therefore, in the circuit we will use the traditional ICs with low power consumption, very cheap price and simple circuit less damage, high durability.

3.2. Design and assembly

Structure of the trap

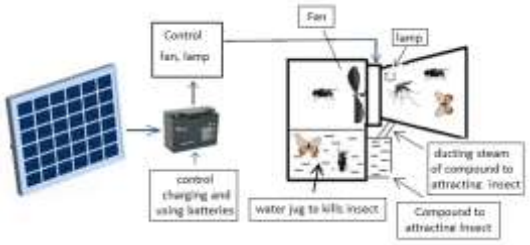


Figure 6. *Diagram of trap structure*

In figure 6. Insects attracted by the light of lamp and scent of the attractant will fly into the funnel of the trap. The fan installed on the rear of the funnel will suck in insects and they are falled into the water. The controller in trap controls charging batteries during the daytime and periodically turns on/off the exhaust fan, lamp when the trap operates at the nighttime.

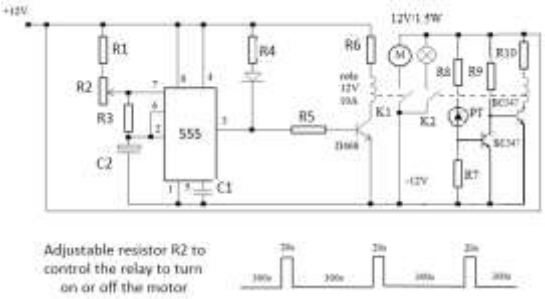
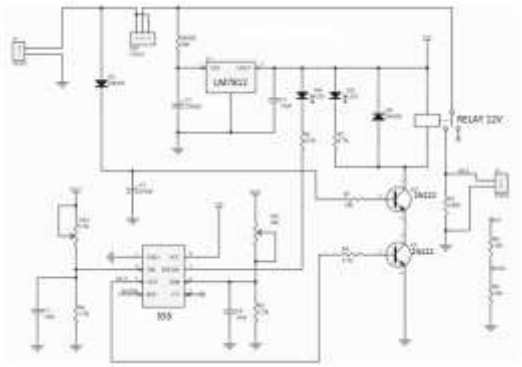


Figure 7. *Schematic diagram to control operation of trap*

Figure 7. is showing shematic diagram for control interval to on/off motor fan and lamp. To suck insects into a water jug, exhaust fan is need running. However, when the fan is constantly running, it makes noise so that the insects are afraid of not getting close to the trap and quickly draining the battery. Therefore, switching the fan on/ off periodically is adjusted as shown in Figure 7. When the night needs to turn on the light to lure insects come; but when daytime does not

need and must be controlled to turn off it. This control is done simply by using a photodiode diode PT and 2 transistors BC547.



Firuge 8. *Circuit that used to control the charging of a battery from solar panel*

The circuit diagram in Figure 8 is used to recharge the battery of traps. The Charge only allows when the voltage of the solar cell must be greater than the battery voltage. When the battery is fully charged, the control circuit will cut the voltage from the solar cell to the battery. This circuit also controls when the battery has low voltage (<11.7V) or when the load is shorted, it will cut and not use the battery to prevent battery damage.

3.3. Experiments

The first version of the trap was made at a test price under 20US$. In it, the most expensive is for solar plate 10W and small batteries 12V/ 1.3Ah. If we supply power for trap by electricity net (case of when the tea gardens near the electricity net), then price of the control circuit and mechanical part of this trap only at 3US$. This is a very cheap price.

+ Test for catching *Empoasca flavescens:* As shown in section 1.B, Because *Empoasca flavescens* has strong attracted to low light, we experimented with light from 12V incandescent lamps, these have dissipation power with 1, 1.5, 2.5, 5 (W) (Figure 10 and Table 1) when the trap was operate at night.

+ Test for catching mosquito: Experiments performed both in daytime (no using lights) and in nighttime with lights and combinations of attractants are lemon tea flavor, sugar water, honey.

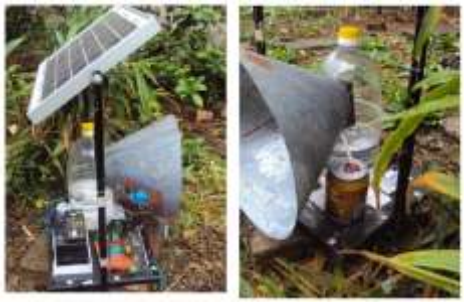


Figure 9. *Experiment trap in the daytime*

Figure 10. *Experiment trap in the nighttime*

Table 1. *Power of lamp and effect of attracting Empoasca flavescens.*

Time experiments	**October**			
Power of lamp (W)	1	1.5	2.5	5
Number of Empoasca is caught	9	15	5	4
Effect of attracting	good	good	bad	bad

Table 2. *Types compound and effect of attracting mosquito. At night the lamp power 1.5W is used.*

Time experiments	**October**		
Type compound	sugar water	honey	lemon tea flavor
Number of mosquitoes is caught during the day	5	3	15
Number of mosquitoes is caught during the night	7	5	25
Effect of attracting	bad	bad	good

Discuss: To get better results when comparing the level attraction to insects of lights in levels of power, colors of light with *Empoasca flavescens* or with other insects or when comparing different attraction level of compound's attractants with mosquitoes, flies we need at least two identical traps located in the same place in experiment. Our experiment is currently due to the initial purpose of asserting the correctness of the operational principle, so a trap is used.

Development direction:

+ Compare the efficiency of attraction on the same pair of traps with different parameters of the attracting attributes (power of light, type compound) to popular tea insect pests such as *Empoasca flavescens, Helopelthis theivora Waterh, Physothrips setiventris Bagn.*

+ Research on the effect of electromagnetic waves, on the frequency of attracting attraction between two sexes of insect pests of tea to make electric oscillators that simulate these frequencies to attract insects like [10] or make affecting to them.

4. Conclusion

Attracting harmful insects to traps and kill them is that it can be performing automatically by the system of electronic circuits.

Power to supply for these electric circuits in the traps can be used from the rechargeable batteries from solar energy or from the grid. By this way, we can create tools to kill harmful insects with low cost. can be applied effectively in practice.

REFERENCES

[1]. Do Ngoc Quy, Tea plant - production - processing - consumption, Nghe An Publishing House, 2003.

[2]. http://www.khuyennongvn.gov.vn/vi-VN/chuong-trinh-nganh-nong-nghiep/tai-co-cau-nganh-nong-nghiep/thai-nguyen-phat-trien-san-xuat-che-theo-huong-an-toan-nang-cao-chat-luong-gia-tri_t114c35n14324.

[3]. Ministry-level scientific research Project No. B2014-TN06-03, *Research and develop integrated solutions to restore the soil environment tea of cultivation in Tan Cuong, Thai Nguyen after 50 years of exploitation and use*, 2014.

[4]. Alessandro Barghini, Bruno Augusto Souza de Medeiros, *UV Radiation as an Attractor for Insects*, Leulos, Vol 9, pages 47-56, 2012.

[5]. Christine Truxa, Kondrad Fiedler, *Attraction to light – from how far do moths (Lepidoptera) return to weak artificial sources of light?*, Eur. J. Entomol. 109: 77–84, 2012.

[6]. H Aliakbarian, A Enayati, A Soltani, Hossein Ameri Mahabadi, Mahmoud Moghavvemi, *Electromagnetic Solutions for the Agricultural Problems*, Advanced Microwave Circuits and Systems, MPRA Paper No. 46047, posted 10. April 2013.

[7]. Masami Shimoda, Ken-ichiro Honda, *Insect reactions to light and its applications to pest management*, Appl Entomol Zool 48:413–421, 2013.

[8]. Gerald S. Pollack, Kazuo Imaizumi, *Neural analysis of sound frequency in insects*. BioEssaysVolume 21, Issue 4, 1999.

[9]. Mr. Sandeep V.Gaikwad, Dr. A.N.Gaikwad, *RF & MW radiation based solution for Insect control in Agriculture: A Review and Proposed System*, International Journal of Scientific & Engineering Research, Volume 3, Issue 12, December-2012.

[10]. https://www.abc.net.au/news/2016-01-19/scientists-discover-frequency-traps-male-yellow-fever-mosquitoes/7084434.

[11]. Chun-jiang Shuai, Hong-en Jia, Xiu-chao Xie, Jin-bin Yao, Feng LV, *Effect of electromagnetic exposure at difference frequencies on euproctis pseudoconspersa's growth and development at different stages*, Journal of Chemical and Pharmaceutical Research, 2014.