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DESIGN OF INSECT TRAP AUTOMATIC CONTROL SYSTEM FOR CACAO PLANTS*

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Abstract

Insect pests attacks on Cacao (*Theobroma cacao* L) plantations are generally controlled using chemical (non-organic) pesticides. Pesticides that are applied continuously can cause pest resistance, pest resurgence, and environmental pollution. Environmental pollution can disrupt the ecosystem due to increased toxic residues in plant tissue or the soil. Therefore, it is necessary to design a pest trap with charm and an automatic actuator based on a microcontroller on the Arduino board. This automatic insect trap is called the Teptrap v1. Five units of the infrared sensor type E18-D50NK are used to detect insect pests. The attractants used were TL lamps, yellow lights and attractants attached to the trap system. Teptrap v1 shows excellent performance during 33 days of research. As evidenced by the fan actuator system that works stably with a catching accuracy of 82.74%, insect drop time is 6 minutes 33 seconds, and the actuator response speed turns on the light, yellow LED and pumps <1 second (± 10 mS). This insect pest control trap can reduce the use of spray pesticides by 20-50%, thereby saving the cost of purchasing pesticides up to IDR 74,468 per hectare of Cacao.

Keywords: Automatic insect trap, cacao plants, insect trap, microcontroller, pest control

1. Introduction

Cacao is one of the agricultural commodities that have the potential to provide great benefits in Indonesia. However, the pest infestation is the major challenge that faced by the Cacao farmers because it can reduced the production by more than 80% (Basri, 2010). According to Habibullah (2018), Cacao production decreased to 658.400 tons in 2016 which caused by the land reduction of Cacao plantation area due to the farmer's inability to reduce the insect pests attack. Insect pest attacks on Cacao significantly affect the decline in Cacao production (Billah *et al.*, 2014). Insect control on Cacao plants generally uses insecticides. The intensity and dose of insecticides that are applied continuously cause pest resistance to insecticides, pest resurgence, and environmental pollution. One of the causes of damage to Cacao is the attack of insect that suck Cacao pods. The affected fruit shows puncture marks

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in the form of black spots on the surface of the fruit. In severe attacks, the entire surface of the fruit is covered with black and dry puncture marks; the skin is harden and cracked. This fruit-sucking insect attack is classified as difficult to eradicate because it tends to be resistant to insecticides (Arif, 2015).

Some simple technologies to attract insect include the use of lamps, yellow binders, and attractants. The community tends to use lights to catch flying pests in agricultural areas (Pertiwi *et al.*, 2013). Flying pests are attracted to gathering at light sources. The use of yellow light (waterproof paper material or yellow LED) is also considered as a solution to attracting insects into the trap. The insects have a high interest to yellow color, which provides a stimulus related to changes in plant color during flowering and fruit ripening (Hakim *et al.*, 2017). Another method to trap the insects use as attractants. The odor caused by fruit or synthetic attractants made of methyl eugenol causes fruit flies, Ceratitis sp. and Bactrocera sp. attracted closer to the material. The aroma of the attractant from the hanging methyl eugenol diffuses in the air so that it can be detected by fruit flies (Hasyim *et al.*, 2010). The results of previous research can be used as a reference for a better pest trap design strategy.

A unique strategy need to be developed to deal with Cacao plant pests on an ongoing basis through the application of technology with low operating costs to increase the profit ratio of farmers through designing pest traps with microcontroller based automatic attractants and actuators. The decoys used are TL-lamps, yellow lights, and attractants attached to the trap system. This design tool is called Teptrap v1. The use of this tool works to effectively reduce the effect of pest attacks in preventing insect attacks on cacao plantations.

2. Materials and methods

This research was conducted at the Laboratory of Energy and Agricultural Engineering, Universitas Lampung, Indonesia. The application of insect traps and data collection was carried out in farmers' Cacao farms in Sukoharjo 1 Village, Pringsewu Regency, Lampung.

2.1. Design Criteria

The insect trap automation system is designed to control fan actuators, automatic feeds, infrared sensors, and pumps that are in the insect trap, to lure insects to approach the tool and drop them into an insect reservoir filled with water. The pest trap automation system uses the ATMega microcontroller on the Arduino board because it is easy to assemble, tough, and stable for the use of measurement data acquisition and control system design in agriculture (Wahyo *et al.*, 2020; Telaumbanua *et al.*, 2019; Triyono *et al.*, 2019). The Microcontroller module design is equipped with an LCD, RTC, and MicroSD Module. The power used to turn on the microcontroller and actuator in the pest trap comes from Solar Cell. The electricity generated by the Solar Cell is in the form of DC voltage so that for actuators that require AC voltage electricity is taken from the Solar Cell which has been through the inverter.

The E18-D50NK infrared sensor has a reading accuracy of 1 mm with a detection distance of 50 cm. This infrared sensor can detect changes in infrared energy. This sensor is used to detect insects lured into the pest trap and insects that enter the pest trap. The design of the types of decoys used in the traps is TL-lamps, yellow multi LEDs, and attractants. The design of actuators used in pest traps is to use a fan, a decoy (TL-lamp, yellow light, attractant) and a water pump with a voltage of 220V and a power of 35 watts. The fan blows the wind to knock down insects when insects detected by infrared sensors are inside the pest trap catching room. The use of a water pump functions to circulate water in the insect collection tub at 06.15-06.30 AM to prevent trapped insects from escape and to make it easier for researchers to count insects (for analysis) manually. The seductive TL-lamp are