Acoustical Methods for Detecting Internal Infestation of Mango Pulp Weevil (*Sternochetus frigidus* Fabr.) on Raw Mangoes (*Mangifera indica L.*)

Nelio C. Altoveros[1], Rogel Mari D. Sese[1], and Celia dR. Medina[2]

[1] Institute of Mathematical Sciences and Physics
[2] National Crop Protection Center
University of the Philippines Los Baños, 4031 College, Laguna, Philippines
E-mail: rmds@physics.uplb.edu.ph; nca@physics.uplb.edu.ph

INTRODUCTION

Since 1987, mango pulp weevils have been slowly infesting mango plantations in Palawan. It started from the southernmost town of Bataraza and has reached the southern part of Puerto Princesa City. However, the northern part of the province is still uninfested (De Jesus, 2000). The province of Palawan has been placed under quarantine to prevent the spread of the insect to other mango producing areas of the country (De Jesus, 1998).

The mango pulp weevil (*Sternochetus frigidus* Fabr.) is a small hard-bodied insect which infests mango fruits. The adult female lays its eggs on a fruit when it is about the size of a chicken egg. The eggs hatch and the larvae bore into the fruit where they undergo development, from larvae to pupa to adult, in the span of 32 days. The adult remains inside for another 37 days. Seventy percent (70%) of the adults exit the fruit by boring a hole directly underneath the pupal chamber. No published studies have yet been done on the behavior of the insect outside the fruit.

Acoustical detection methods have been done on fruits such as papayas and mangoes. These were used to detect the presence of fruitflies (Hansen, 1988 & Sharp, 1988). The instruments used reached an accuracy of as high as 80%. However, the detection method relies on the feeding sounds and not on the actual movement of the insect. This project aims to develop an instrument that will detect the presence of mango pulp weevils using acoustical methods, and to interface the instrument to a microcomputer. The instrument will rely on the movement of the insect and not on its feeding sound.

METHODOLOGY

Two detection methods were done using different sensors. The first method uses a piezoelectric sensor to detect the vibrations produced by the insect inside the fruit. The sensor is placed inside a chamber and is mounted on a thick marble slab and styrofoam to prevent external vibrations from interfering with the reading.

Initial tests showed that vibrations observed are very small, approximately 3 mV only. An amplifier stage was added to increase the voltage level to the 0-5 volts voltage range. The instrument was then interfaced to an Intel Pentium 166MHz microcomputer using a custom-made analog-to digital converter (ADC) card containing an AD671 12-bit ADC chip (Fig. 1).

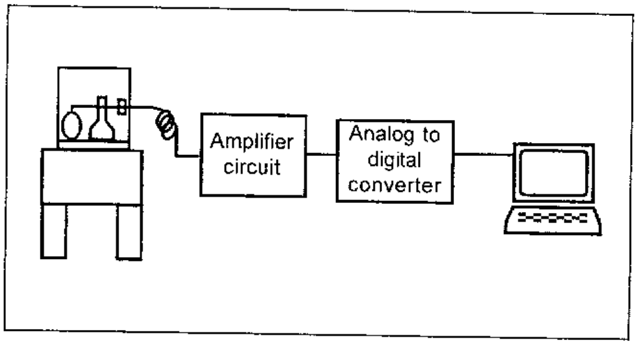

Fig. 1. Schematic diagram of the instrument

A program was made using Turbo C to control the reading and analysis of data. Each mango was tested for two minutes with a 20-second stabilization time to remove unwanted vibrations caused by the placement of the sensor on the sample. A criterion was employed to determine whether the fruit is infested or clean. Three hundred mangoes were tested. After testing each mango, each was immediately cut open to verify the result.

The second method will use three medical stethoscopes interconnected by a hollow PVC tubing with only one opening. In the opening, a condenser microphone will be placed which is then connected to an amplifier circuit. The instrument will also be interfaced to the microcomputer using the same ADC card in the first method. The same program will also be used.

STATUS OF THE PROJECT

The project is still ongoing and the first detection method was used in its first trial run. Of the 300 mangoes, 120 of them are infested. Only 44 infested mangoes were correctly detected. Out of the 180 clean mangoes, 127 were correctly identified (Fig. 2). Overall, the accuracy of the instrument was measured to be 57%. The relatively low accuracy is attributed to the high electrical noise due to the proximity of the circuit to the microcomputer. Noise level was measured to be at a maximum of 0.21V. Voltage spikes due to movement was then set to be any voltage value greater than the maximum noise level. For a fruit to be classified as infested, the number of voltage spikes should at least be four (Fig. 3). No agitation method was done to ensure that the insect inside the fruit is moving since no behavioral studies were done regarding this aspect.

Currently, improvements are being made on the first method to increase the accuracy of the instrument. Filters are being added to the instrument to reduce the noise level. The program is also being modified to enable the viewing of the wave pattern made during each reading. The sensor for the second detection method is being made and pre-tested. Noise reduction methods are also being done to ensure that the noise level in the second method is kept low. The instruments will be then tested during the start of the next mango season around December.

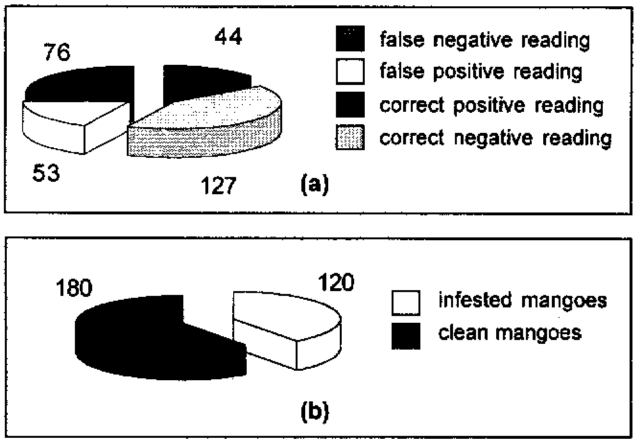

Fig. 2. Charts of results: (a) number of correct and incorrect positive and negative readings; (b) number of clean and infested mangos in a sample of 300

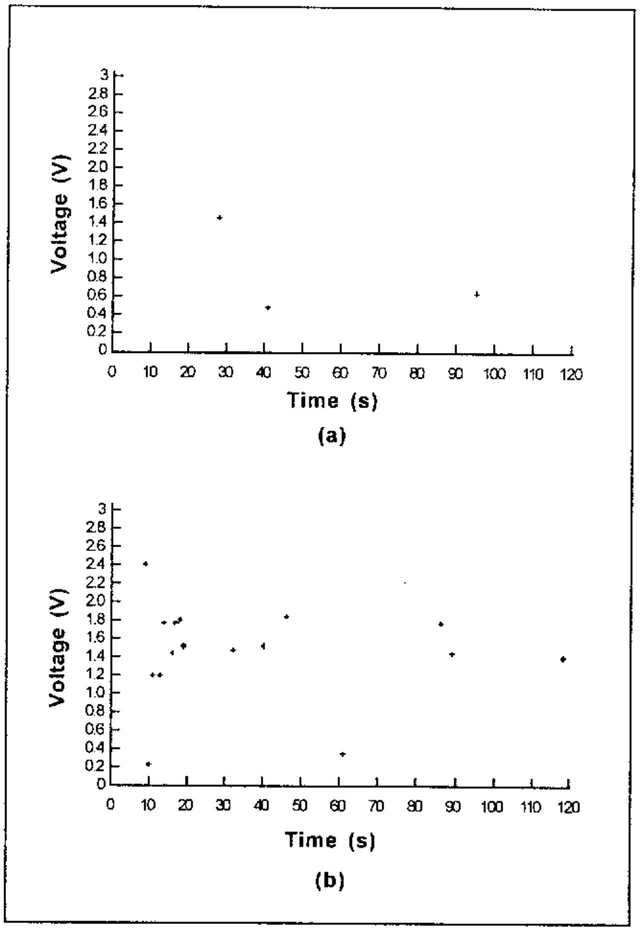

Fig. 3. Comparison of the plotted data points of (a) clean mango sample and (b) infested mango sample. Notice that an infested sample exhibits more spikes than a clean sample

ACKNOWLEDGMENT

The authors would like to acknowledge the National Crop Protection Center for providing financial support for the project.

REFERENCES

De Jesus, L.R.A. & R.R. Gabo, 2000. Life history and host range of the mango pulp weevil in Palawan, Philippines. *Phil. Agri. Sci.* 83(2):145-150.

De Jesus, L.R.A. & F. Cortez, 1998. Field infestation and chemical control of the mango pulp weevil in Palawan. *The Phil. Agriculturist.* 81(3 & 4):131-140.

Hansen, J.D. et al., 1988. Acoustical detection of oriental fruit fly larvae in papaya. *J. of Econ. Entomology.* 81(3):963-965.

Sharp, J.L. et al., 1988. Flexible acoustical device to detect feeding sounds of Carribean fruit fly larvae in mango, Cultivar Francis. *J. of Econ. Entomology.* 81(1):406-409.