Electronic McPhail trap for automatic south american fruit fly monitoring

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Abstract

Apple is an important crop among the cultivated fruit crops in Brazil. Although, South American fruit fly is an important insect-pest that causes losses of production if not controlled. Monitoring involves placing one McPhail trap every two hectares and checking them weekly, which requires significant labor. With the scarcity of workers, and their high cost, a solution could be the use of electronic traps, which automatically identify and compute South American Fruit flies. Thus, the objective of this work was to evaluate in apple and pear orchards McPhail electronic traps and their effectiveness in identifying fruit flies and their attractiveness in relation to conventional McPhail traps. The electronic traps were effective in detecting South American fruit fly, although, they captured four times less flies in relation to conventional McPhail traps. The technology showed effectiveness. Future developments may consider redesigning the sensor distribution or implementing an alternative threshold control for the application of insecticides.

Keywords: *Anastrepha fraterculus*; YOLOv8; apple; pear.

1. Introduction

Apple crop has been stable in Brazil, with about 33,000 ha in the past 6 years, and yield around 35 ton.ha^{-1} (IBGE, 2025). Worldwide, Brazil figures as the 13th biggest producer of the fruit (FAO, 2025). One of the main challenges in Southern Brazil is the presence of South American fruit fly, *Anastrepha fraterculus* (Wiedemann), and its damage caused in the fruits (Borges et al., 2021). This fruit fly survives whole-year by

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biting native fruits, and when apple fruitlets area available, the female flies migrates to the orchards to feed the fruits and reproduce, causing damage to the fruits (Borges et al., 2021). The method for controlling this plage is through McPhail traps filled with attractive solution and installed at least one trap every two hectares. Control measures are recommended when there are 0.5 flies per trap per day (Borges et al., 2021; Medeiros, 2025).

Inspecting the traps manually is labor-intensive because each trap must be opened, and the solution with insects sieved and counted. An alternative to optimize labor could be the use of electronic traps that count the amount of fruit flies captured. Thus, the objective of this experiment was to evaluate the effectiveness of electronic traps to compute the capture of fruit fly in apple and pear orchards.

2. Methods

The electronic traps (Figure 1) were designed to operate off-grid. They were powered by two solar panels that charged two 12 V, 7 Ah batteries, and included a charge controller for energy management. A 4-megapixel camera was installed at the top of the McPhail traps' central cone. The energy of the batteries passed through a circuit controlled by an Arduino nano, a real time clock module and a step-down module (from 12 to 5 V) to make energy available to the Raspberry Pi 4 from 7 AM until 7 PM to prevent energy loss when the flies are not active. A Raspberry Pi, configured with a calibrated YOLO model, detects fruit flies in a modified McPhail trap. For details on AI algorithm calibration, see Medeiros (2025).

Figure 1. Electronic trap assembled in the orchard.
Source: Medeiros (2025, p. 57)

The output of the trap was a .txt file with the GNSS coordinate, time, date, and number of detections, as well as the image of the fruit fly.

3. Results and Discussion

In the field, the four installed traps were able to detect fruit fly. During the 45-day evaluation period, due to the significant variability of scenarios, insects, and suspended particles in the attractive solution, there were false positives, particularly in identifying bees as fruit flies. From a set of fifty images, with and without the target insect, thirty images had flies, and an average of two per image, totalizing sixty flies, and twenty did not have. The model correctly predicted fifty-four flies (90% of accuracy).

In the manual inspection of both conventional and electronic traps, overall, from December 16th, 2024, until March 31st, 2025, the four conventional traps collected 810 fruit flies, whereas the four electronic ones, installed nearby, collected 199, corresponding to four times less captures than the conventional traps (Figure 2).

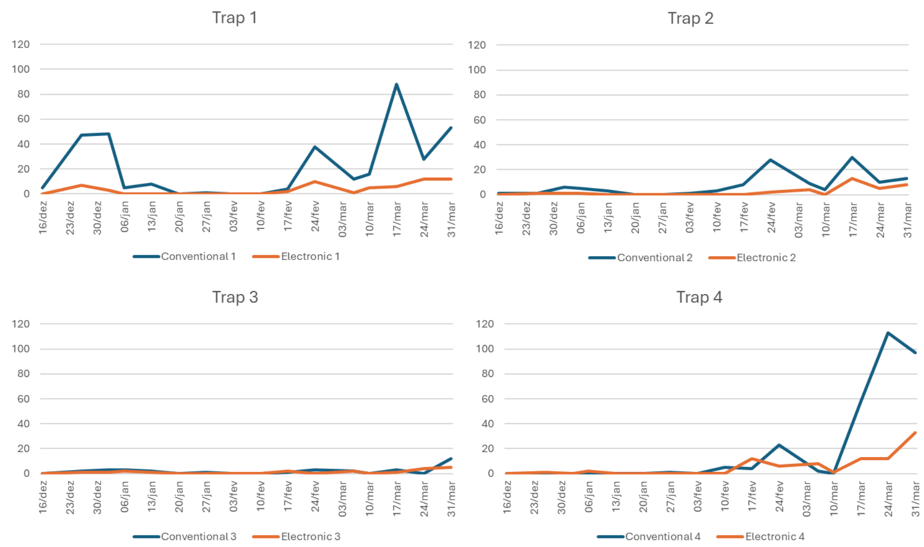

Figure 2. Entrapped South American fruit flies from electronic and conventional traps in the cropping season of 2024/25.

4. Conclusion

The prototype is currently under development and proved to be capable of detecting fruit flies. The model still need more calibration to tackle the diversity of insects and environments found in the orchards. From an agronomic perspective, the electronic design repelled the flies. We must either redesign the components or assess a new threshold of fly/trap/day for chemical control if the issue persists. Communication protocols will enable each trap to automatically transmit data, probably via LoRa.

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