Development of Autonomous Control Technology for Harmful Strawberry Pests in Florida

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Summary

The project aims to enhance pest management in strawberry farming by developing a targeted release system of predatory mites. The focus is to improve the labor-intensive traditional methods, by creating precise mite deployment and an early detection vision system. As we assess the performance of our first prototype, we have identified areas that require improvement to increase the overall system efficiency. These constructive findings will guide the development of our next prototype.

Methods

Our project, to address the urgent need for sustainable and labor-efficient pest management solutions in commercial strawberry farming, has made noteworthy progress despite challenges. The focus of this project is to transform the conventional, labor-intensive hand-release methods of predatory mites into a technologically advanced, efficient system that simplifies biocontrol procedures. The main objective of our project was to design a mechanism for the safe and targeted release of predatory mites onto strawberry plant leaves. We have successfully conceptualized and built the first prototype of this mechanism, enhancing the precision of mite deployment and thereby improving its effectiveness in pest control.

Prototype Development

The initial prototype of the mite releaser end-effector (Figure 1) was constructed by altering the Simeoni Tecnogreen Fertil Dispenser (Sacile, Italy). A solenoid, managed by an Arduino, was linked to the release valve and powered by a 16 V lithium polymer battery. A 9 V DC step-down converter transmitted power from the battery to the Arduino, and the Arduino powered a 5 V relay, allowing 13 V to flow from the battery to the solenoid. Positioned at an angle to enable gravity-aided flow, the dispenser was designed with an adjustable release chamber to allow a low flow rate of vermiculite at every valve opening.

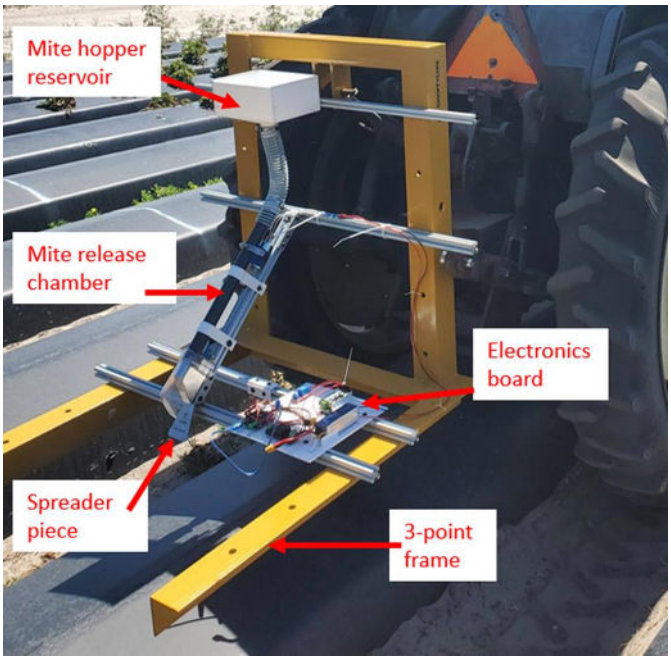

Figure 1. Mite releaser prototype mounted on a tractor.

Deployment

The prototype was mounted on a CountyLine Carry All 3-point rear attachment platform frame. From preliminary testing, two release angles (45 and 35.5 degrees) were found to ensure consistent release of mites without further prodding of the releaser. For all other release angles, the prototype needed to be nudged due to friction in the tube walls, to make the vermiculite flow .

Results

The quantity of vermiculite released for each angle was quantified by manually operating the releaser 10 times (Table 1). The vermiculite was collected in a beaker and then placed in an Eppendorf tube for a more precise volume reading. The volume was recorded, and the average for each angle was computed.

Table 1. Volume of Vermiculite released for 2 release angles

	Volume for 45 degrees release angle (ml)	Volume for 35.5 degrees release angle (ml)
1	1.25	1.5
2	1.05	1.1
3	1.05	1.1
4	1.25	1.15
5	1.15	1.15
6	1.2	1.1
7	0.8	1.05
8	1	1.2
9	1.1	1.25
10	1.05	1.15
Avg	1.09	1.175

Dispersion Spread Area

The dissemination area of vermiculite was evaluated from a releaser elevation of 7.5 inch and an angle of 45 degrees. The release height was adjustable; however, the vermiculite was dispensed at a 7.5-inch height to be closer to the plant and to minimize its spread. The extent of the vermiculite's spread was gauged by dropping it onto a sheet of paper. The lengths of both the long and short sides were recorded and multiplied to determine the rectangular area (Fig. 2.). Strawberry plant canopies growing to at least 12 inches in diameter, corresponding to an area of 113.1 square inches, and the study's mite releaser, which covers half that area, can minimize mite loss with accurate centering and can be adjusted with a separate spreader piece if a wider spread is desired.

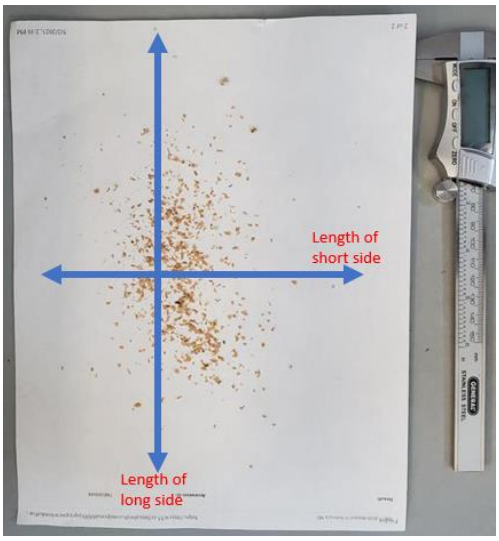

Figure 2. Area measurement for mite releaser

It was concluded that the mite releaser has an average spread area of 56.87 square inches with a standard deviation of 10.22 square inches (Table 2).

Table 2. Spread Area of Released Vermiculite

	Length of short side (in)	Length of long side (in)	Total area (in^2)
1	6.25	8.75	54.688
2	5.875	8.5	49.938
3	7	8.75	61.250
4	7.75	8.375	64.906
5	6.5	8.5	55.250
6	4.5	8	36.000
7	6.5	8.675	56.388
8	7.5	9.5	71.250
9	8.5	8	68.000
10	6	8.5	51.000
Avg	6.638	8.555	56.867
Std	1.122	0.427	10.220

Takeaways

The findings of this study offer several insights that can be applied to improve pest management practices on the farm:

1. Optimized Release Mechanism: By using a precise angle of 45 degrees at a 7.5-inch height, the mite releaser achieves an effective and consistent dispersion of vermiculite, minimizing the need for manual adjustments. Growers can adapt these specifications in their equipment for more consistent mite release.
2. Efficient Coverage Area: The study determined that the mite releaser's average spread area corresponds to roughly half the area of a typical strawberry plant canopy. By accurately locating the center of the plant, growers can ensure maximum efficiency in mite deployment, reducing loss and improving pest control effectiveness.
3. Next Steps for Implementation: While the study's prototype shows promising results, growers interested in adopting this technology should consider collaboration with our team to tailor the system to their specific field conditions, including factors such as crop density, topography, and existing machinery.

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