Harnessing Methyl Jasmonate Epigenetic Defense Modulation Through an Autonomous Robotic Precision Spraying System for Targeted Pest Control

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Globally, pests destroy over 40% of crops annually. Traditional pesticides are highly harmful to the environment and human health, and current application methods—either wasteful mass spraying or inefficient, costly hand spraying—demand technological innovation. Our project addressed this global crisis in two phases. The first phase pinpointed Methyl Jasmonate (MeJA), a plant hormone naturally produced in response to insect attack, as a sustainable alternative to pesticides. While initial MeJA tests demonstrated high efficacy in reducing pest count and leaf damage, high concentrations of MeJA also severely stunted plant growth by increasing the concentration of GA2ox3/7 oxidase enzymes, which destroy the growth hormone Gibberellin. To address this issue, double-stranded RNA were custom designed and synthesized to silence those growth-suppressing enzymes. In order to ensure effective dsRNA delivery, stable carbon dot nanocarriers were constructed to protect unstable RNA from harsh environments. The second phase engineered an autonomous vehicle for precisely deploying the growth-regulated MeJA. The vehicle utilizes mecanum wheels for precise maneuvering and linear actuators for height adjustment across varying crop levels. We integrated a complex custom detection pipeline using SIFT-based keypoints and a YOLOv5-inspired network to recognize small pests accurately in real-time. The vehicle then sprays the growth-regulated MeJA solution adaptively based on the identified pest count. This precise application significantly saves resources and time, ultimately reducing crop yield loss by ~40% compared to traditional hand-spraying. Overall, our project offers a promising strategy to make future agriculture safe, sustainable, and efficient.

Awards Won:
First Award of $6,000
EU Contest for Young Scientists Award
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