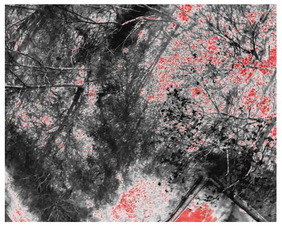

Detecting tree of heaven using drones for the management of spotted lanternflies, a new invasive insect in West Virginia

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INTRODUCTION

The Spotted Lanternfly (*Lycorma delicatula*) is an invasive pest native to China and was introduced to the United States in 2014 (Barringer et al. 2015). Currently, the spotted lanternfly was detected in four counties of West Virginia and would establish and threaten the agricultural and forest ecosystems in the state. Currently, no effective trapping methods for spotted lanternflies are available, and pest managers are solely relying on the ground survey to detect trees of heaven (*Ailanthus altissima*), the most preferred host plant of the spotted lanternfly (Uyi et al. 2021). During the past ten years, drones have been used in detecting invasive plant species and plant protection, which can be used potentially for the detection of the tree of heaven (Bauer et al. 2015).

OBJECTIVE

- To determine the optimal drone flight altitude for detecting seed clusters of the tree of heaven
- To develop an aerial survey method for detecting and mapping the tree of heaven using drones and optical sensors

MATERIALS AND METHODS

- A series of aerial surveys with drones were conducted at every 5 m altitudes (up to 90 m) above the tree canopy.
- Five trees were surveyed to detect seed clusters hanging on trees in February and March in Morgantown.
- Rotary-wing drones equipped with different optical sensors (Fig. 1) were used.
- A validation aerial survey in 2.6 ha was conducted by auto-piloted drone flight.
- Aerial images were downloaded from the drones, and Pix4D (Pix4D, Prilly, Switzerland) was used to stich and georeference aerial imagery.
- DJI Thermal Analysis Tool 2 (DJI, Shenzhen, China) was used to measure temperature of seed clusters and branches of tree of heaven from the thermal images.

Fig. 1. Drones used for this study: Mavic Enterprise Advanced with Thermal and RGB sensors (A), and DJI Inspire 2 with NIR and RGB sensors (B), and Phantom 3 with NDVI and RGB sensors (C)

Fig. 2. RGB Image of tree of heaven at different flight altitudes above tree canopy

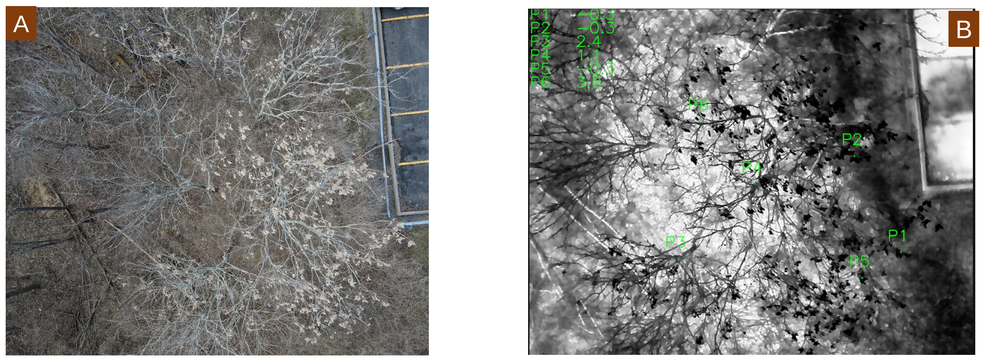

Fig. 3. RGB (A) and thermal (B) images with temperature measurements in Celsius. Note that the seed clusters (P1, P2, and P5) were cooler than branches (P3, P4, and P6)

Fig. 4. Aerial trajectory of drone for validation survey (A) and Mapped image from validation survey with tree of heaven identification (B)

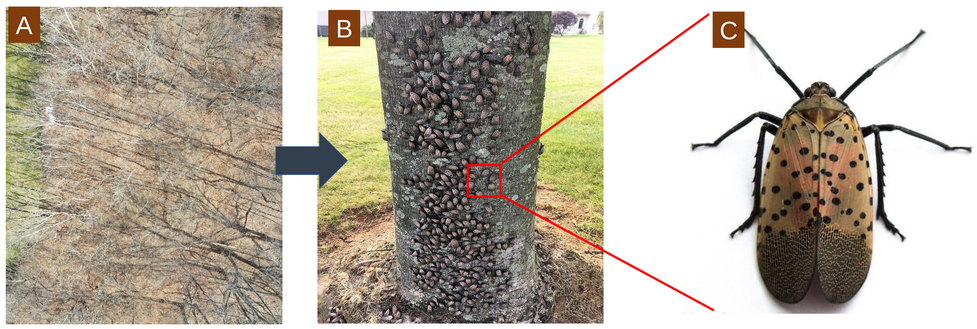

Fig. 5. Aerial image of location with tree of heaven (A), spotted lanternflies on tree of heaven (B) and spotted lanternfly adult (C)

RESULTS & DISCUSSION

- Seed clusters of tree of heaven were detectable from RGB image taken (Fig. 2). It was found that the tree of heaven can be detected at < 70-m flight altitude above the ground.
- Thermal sensors detected the heat signatures of seed clusters of the tree of heaven (Fig. 3). The temperature of seed cluster were lower than temperature at the branches. NIR (near infrared) sensor couldn't detect seed clusters of tree of heaven during the winter.
- Tree of heaven with seed clusters were identified during the validation survey (Fig 4), indicating that trees of heaven can be detected by using aerial survey during winter season.
- Being the major host of spotted lanternfly, tree of heaven can be used for the monitoring and management of this invasive insect pest after locating tree of heaven with drones (Fig. 5).

CONCLUSION & FUTURE STUDY

This study demonstrated that detection of the tree of heaven would be possible with aerial surveys with drones equipped with optical sensors, which can help in the early response and prioritize the efforts on spotted lanternfly management. Based on the results of this study, we will develop a field protocol for the detection of tree of heaven with aerial surveys which can help generate risk map of spotted lanternfly in West Virginia. Future study will be focused on detecting both male and female tree of heaven in different seasons.

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