

Next-generation alcohol biosensor for detecting the emission of stress-induced ethanol from trees

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1. Background

Ambrosia beetles (Coleoptera: Curculionidae) are destructive insects of horticultural trees. Ethanol is emitted from trees in response to various physiological stressors, especially flooding and freezing. Ambrosia beetles use ethanol to locate vulnerable trees. Since trees in the early stages of physiological stress can be asymptomatic while emitting stress-induced ethanol, rapidly detecting the emission of ethanol could aid in identifying trees at risk of being infested by ambrosia beetles.

3. Main findings

The BACtrack biosensor detected ethanol emitted from the bark of flood-stressed sugar maple, *A. saccharum* (Figs. 1-3). The biosensor shows promise for identifying trees at risk of mass attack by ambrosia beetles.

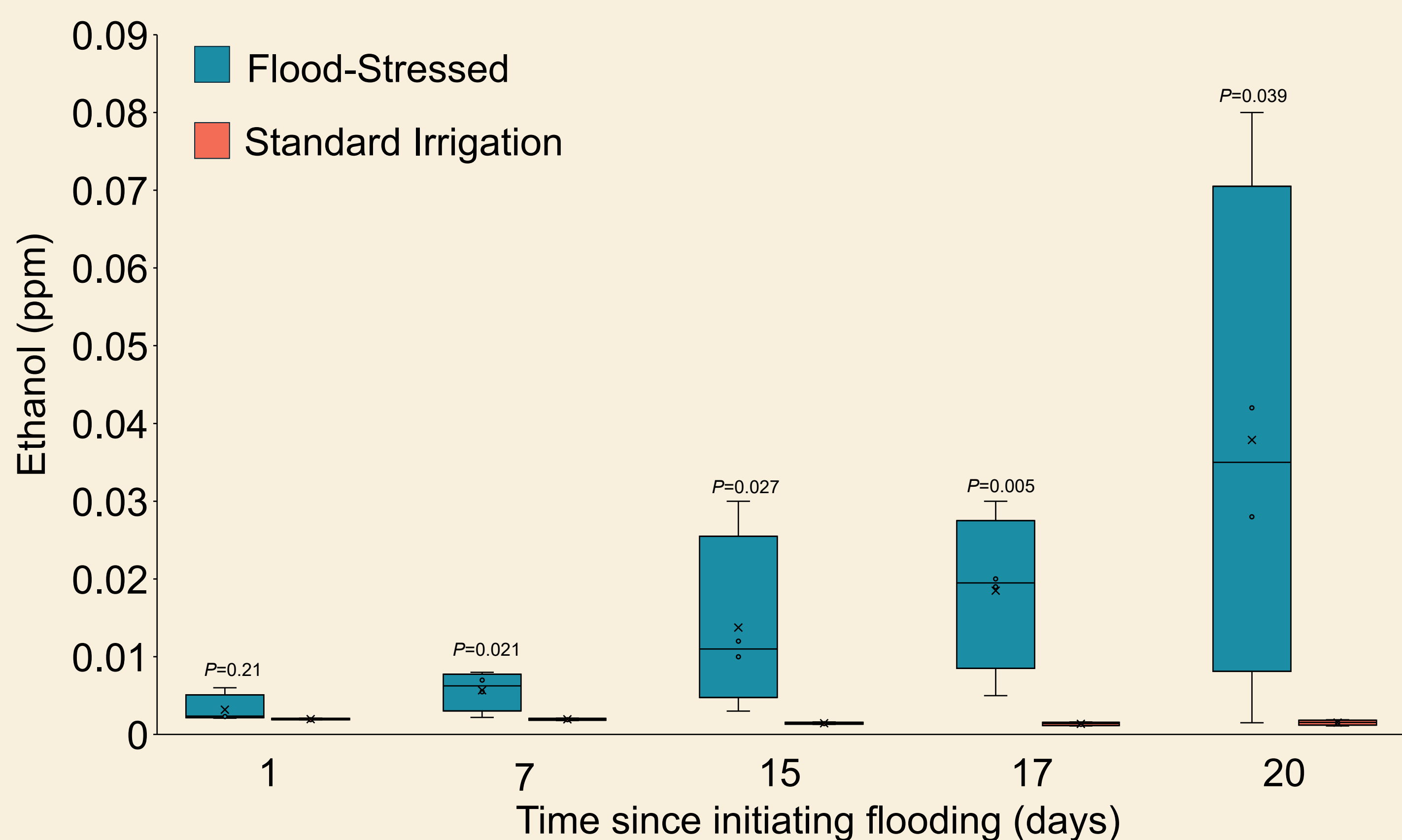


Fig. 2. Time-course ethanol emission from sugar maple, *A. saccharum*, subjected to flood stress and standard irrigation detected using a BACtrack biosensor. During the experiment, the trees were held within a walk-in growth chamber (n=4 trees/treatment). A Student's t-test was used to compare ethanol concentrations ($\alpha=0.05$).

4. Methods

- Sugar maple, *Acer saccharum*, trees were flood-stressed using a pot-in-pot system and held within an environmental growth chamber (25 °C; 16:8, L:D). Flooding was maintained throughout the experiments. Non-flooded control trees received a standard irrigation regime.
- The BACtrack® wearable alcohol biosensor (SKYN, San Francisco, CA) was selected for testing. BACtrack Skyn was designed to measure alcohol emitted from skin in near real-time every 20 sec. The BACtrack biosensor was positioned at the base of stems on flood-stressed trees. A gasket was used to ensure a seal between the bark surface and the biosensor.

- The BACtrack Skyn app installed on an Apple iPhone was used to display in near real-time the detection of alcohol ($\mu\text{g/L}$) over a 30 min duration for each tree. Recordings were uploaded to a cloud-based storage.

2. Question

Can a next-generation alcohol bio-sensor detect the emission of ethanol from flood-stressed trees?



Fig. 1. BACtrack ethanol biosensor attached to sugar maples subjected to (A) standard irrigation and (B) flood stress. (C) Ambrosia beetle (arrow) and BACtrack biosensor on a flood-stressed sugar maple stem. (D) Transdermal alcohol content ($\mu\text{g/L}$) recorded in near real-time from a flood-stressed sugar maple tree as an ambrosia beetle has initiated tunneling (arrow).

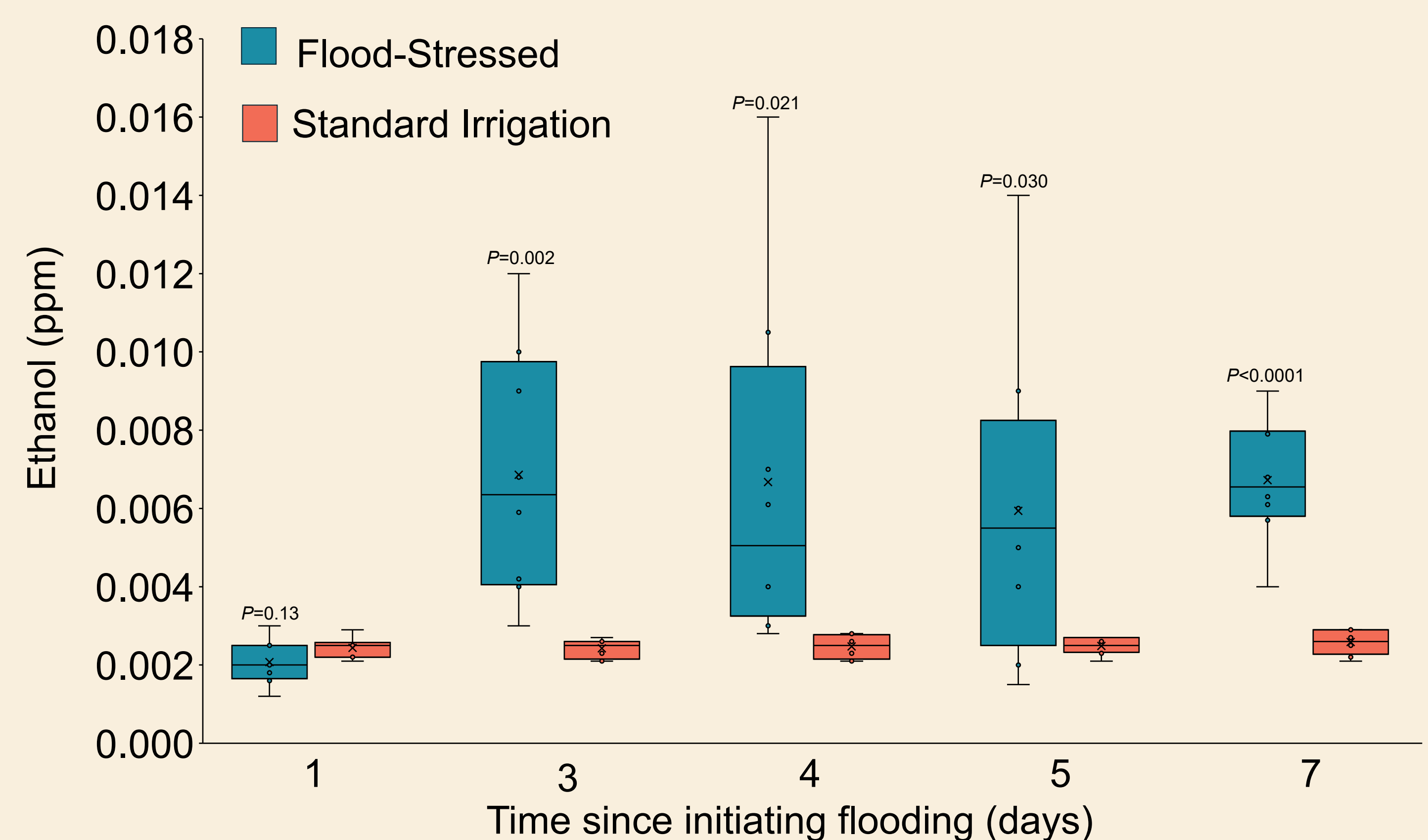


Fig. 3. Time-course ethanol emission from sugar maple, *A. saccharum*, subjected to flood stress and standard irrigation detected using a BACtrack biosensor. During the experiment, the trees were deployed within a deciduous woodlot (n=8 trees/treatment). A Student's t-test was used to compare ethanol concentrations ($\alpha=0.05$).

5. Future Studies

- Future studies will determine if the BACtrack biosensor can identify vulnerable trees before mass attack by ambrosia beetles.
- SPME-GC-MS will be used to confirm the emission of ethanol and correlate with the BACtrack biosensor.

6. Acknowledgements

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