

Allelopathic cover crops, roller crimping, and soil steaming as an integrated non-chemical weed management strategy in tomato

Matthew Butler, Alaina Richardson, Te-Ming Tseng
 Department of Plant and Soil Sciences, Mississippi State University, Starkville, MS 39762

Background

- Yellow nutsedge propagates via persistent tubers and can evade most herbicides, creating long-term challenges in crop management.
- Soil steaming is a **non-chemical**, thermal treatment that offers promising organic-compatible control.
- Integrating steaming into IWM could provide sustainable, efficient suppression—but **depth** and **soil moisture** likely influence its effectiveness.
- **Hypothesis:** Longer steaming and shallower depths yield higher tuber kill rates, while wet soils and deeper placements reduce the effectiveness.

Objectives

1. Compare the efficacy of **three steaming durations:** 1, 5, and 45 minutes.
2. Evaluate tuber viability and emergence at **three burial depths:** 5, 13, and 20 cm.
3. Validate performance under both **controlled (greenhouse)** and **real-world (field)** environments—capturing one variable rainfall scenario.

Methods

- Trial Design**
- **Greenhouse:** Two experimental runs, pots placed under tarp for steaming.
 - **Field:** Pots buried 25 cm below soil, steamed in-place; two runs (dry vs. wet conditions).
 - **Design:** Two-factor split-plot with steaming duration × burial depth.
- Steaming Treatments**
- Mobile steam generator (Steam 'N' Air™ SG12).
 - Exposure times: **0 (control), 1, 5, or 45 minutes.**
 - Tarp enclosure used to retain steam until soil reached 82–85°C.

- Measurements**
- **Tuber emergence (%)** – number of sprouted tubers.
 - **Viability (%)** – post-steaming regrowth test of ungerminated tubers.
 - **Non-viability (%)** – tubers failing both initial and regrowth germination.

- Soil & Containers**
- Clay-loam (greenhouse) and silty-loam (field).
 - PVC pots (25.5 cm tall) with screened bottoms for drainage.
 - Yellow nutsedge tubers (10 per depth) buried at **5, 13, or 20 cm.**

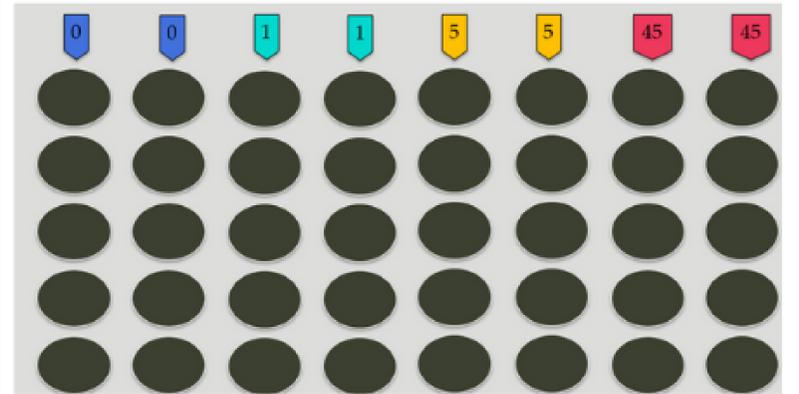


Figure A.1 Experimental layout of PVC pots installed in field plots, illustrating column assignments for steaming treatments. Colored flags with numbered labels denote the steam duration assigned to each treatment group (0, 1, 5, or 45 minutes). Each black circle represents an individual pot, serving as a replication within its respective treatment group.

Results

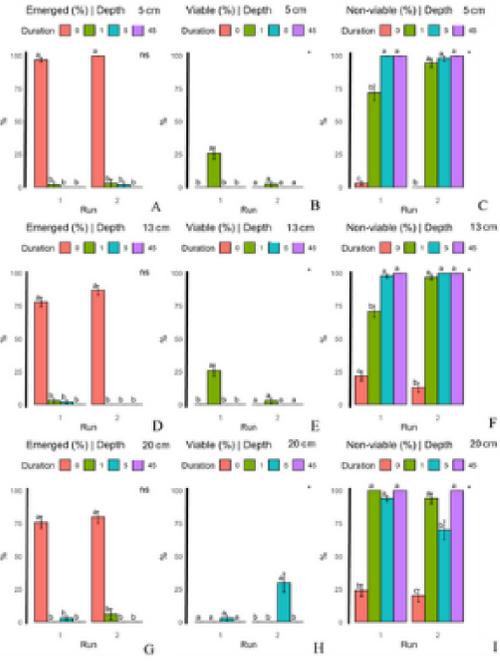


Figure A.2 Yellow nutsedge (*Cyperus esculentus* L.) tubers burial depths of 5, 13, and 20 cm and steam durations of 0 (nontreated), 1, 5, and 45 minutes in the greenhouse.

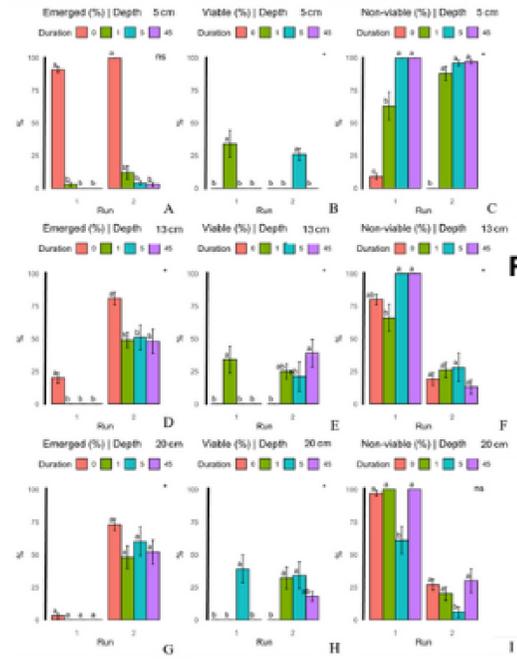


Figure A.3 Yellow nutsedge (*Cyperus esculentus* L.) tubers burial depths of 5, 13, and 20 cm and steam durations of 0 (nontreated), 1, 5, and 45 minutes in the field.

Discussion & Conclusion

Effectiveness of Steaming

- In both greenhouse and field Run 1, 5 minutes of steaming suppressed >98% of tubers, even at 20 cm depth.
- 45 minutes achieved total suppression in controlled conditions, but extended steaming is impractical due to labor and fuel costs.

Influence of Depth & Soil Conditions

- Shallow tubers (5 cm) were consistently controlled across all treatments.
- Deeper tubers (13–20 cm) showed some survival, especially in wetter soils.
- Field Run 2 (25 cm rainfall): steaming penetration was reduced, with >50% emergence at depth despite 45 min exposure.
- Soil moisture increased heat capacity, preventing adequate thermal transfer.

Practical Implications

- A 5-minute steaming treatment appears to be the most efficient balance between efficacy and resource use under ideal conditions.
- Limitations: wet soils, compacted soils, and deeper tubers reduce effectiveness.
- Steaming should not be viewed as a standalone solution, but as a component of Integrated Weed Management (IWM) strategies.

References

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