Microbial Risk Assessment of Soil Amendments in Organic Romaine Lettuce, California's Low Desert, 2023 Season

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Introduction

Public Health Concerns

Despite treatment protocols, mounting evidence indicates biological soil amendments of animal origin (**BSAAO**), commonly used as fertilizers in conventional and organic vegetable farming, may facilitate the growth and persistence of pathogenic E. coli strains in leafy greens, posing significant food safety risks. Consequently, there is an urgent need for alternative fertilization strategies. Notably, organic farmers are exploring sugar-based liquid fertilizers derived from plant sources, such as corn-steep liquor, as potential BSAAO replacements. However, the microbial food safety implications of these novel organic inputs remain largely undetermined, necessitating rigorous scientific investigation to safeguard public health and ensure sustainable organic vegetable production.

Aim

The goals of this study are three folds:

1. Evaluate survival of inoculated **rifampicin-resistant *E. coli* TVS 353** in soils amended with heat-treated poultry pellets **(HTPP),** seabird guano pellets **(SBG),** and corn steep liquor **(CSL)** used to grow organic romaine lettuce in California.

2. Verify the effect of environmental factors on the survival of ***E. coli* TVS 353** in organic fields that use soil amendments.

3. Quantify the number of ***E. coli* TVS 353** on lettuce at the end of the growing season.

Method

Experimental design:

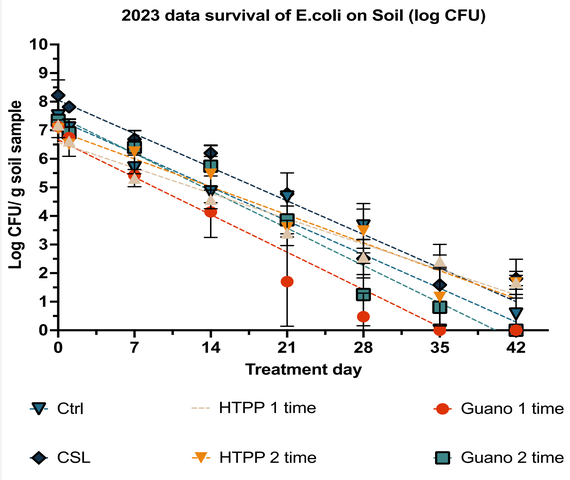
- Eight BSAAO treatments including: Control (no amendment), HTPP-1 (one application) , and HTPP-2 two applications), SBG-1 and SBG-2, CSL, CSL+HTPP, and CSL+SGB in California's Imperial Valley during 2022-2023.
- Romaine lettuce transplants were planted in plots, and soils were inoculated with Rifampicin-resistant *E. coli* TVS353 (7-8 log CFU/mL) were applied to plots and were quantified via direct plating and most probable number (MPN) assays from soils and lettuce plants (at harvest date) over 42 days.
- Weather data and soil temperature and moisture data were recorded during the trial duration. Each treatment was performed in triplicate plots planted with romaine lettuce.

Results

Results summary:

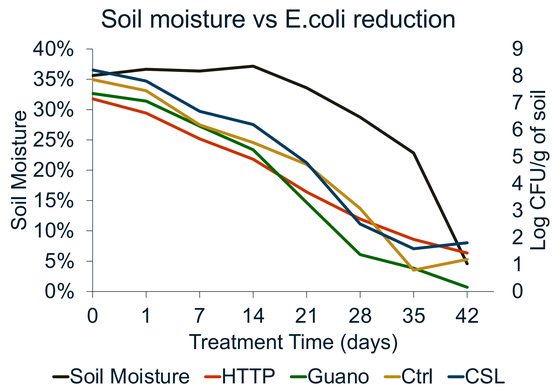
1. All treatments showed a 3-5 log CFU/g reduction of *E. coli* in soils within 21 days and ~7 log CFU reduction by day 42 with no significant differences ($p > 0.05$) between treatments.
2. Increased *E. coli* reduction in soils correlated positively with longer sunlight exposures during the growing season
3. CSL treatments supported higher levels of *E. coli* on the lettuce plants compared with BSAAOs ($p < 0.05$).

Part 1 – *E. coli* survival on the soils



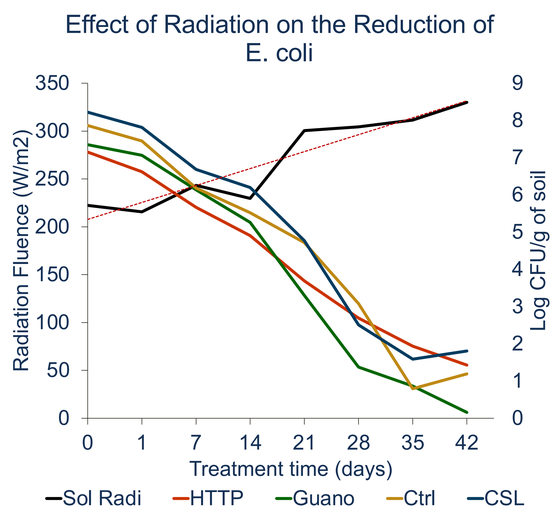
Result 1. There is **no significant difference** between the control and different types of soil amendments in promoting the growth of *E. coli* in organic agricultural fields. The examined soil amendments did not substantially promote the growth of *E. coli* in the soil of organic fields.

Part 2 – Environment factor effect on the *E.coli* reduction rate



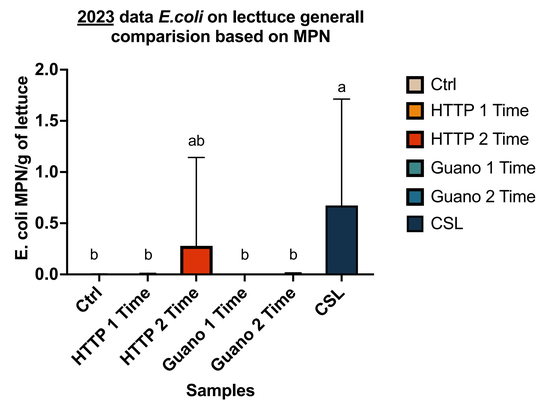
Result 2.1 Data showed a **Weak** correlation between **Soil moisture and *E.coli* reduction with R^2 values at 0.66**

2.2 Solar radiation and E.coli reduction correlation

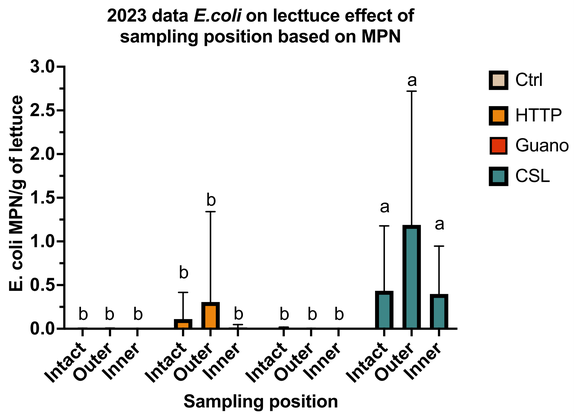


Result 2.2 Data showed a **Strong** correlation between **Solar Radiation and *E.coli* reduction with R^2 values at 0.95**

Part 3 – Quantification of *E. coli* on lettuce heads



Result 3.1 The application of corn-steep liquor led to greater amounts of ***E. coli*** detected on lettuce at the end of the growing season.



Result 3.2 ***E. coli*** was uninformedly distributed throughout the lettuce head.

Significance:

The findings suggest that microbial risks associated with liquid-based fertilizer in comparison with treated BSAAO may differ in organic lettuce production in the southwest desert.

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