

Spatial and temporal factors affect pathogen survival in soils containing commonly used amendments in organic agriculture

A combination of weather- and amendment type affect pathogen survival and transfer to cucumbers in fields. Poultry litter and other biological soil amendments are commonly used fertilizers in fruit and vegetable production and can introduce enteric pathogens like *E. coli* O157:H7 or *Salmonella* previously associated with outbreaks of illness linked to contaminated produce. *E. coli* survival duration in soils covered with plastic mulch or uncovered and containing poultry litter, heat-treated poultry litter pellets were evaluated. Nitrate levels on day 30 and moisture content in soils on day 40 on specific days were good predictors of *E. coli* survival in soils; however, knowledge of the combination of year, amendment and mulch type was a better predictor. Different cumulative rainfall totals from year to year most likely affected the transfer of *E. coli* from soils to cucumbers and survival durations in soil. *E. coli* survival in soils can be extended by the addition of several poultry litter-based soil amendments commonly used in organic production of fruits and vegetables and is highly dependent on temporal variation in rainfall.

Reference:

Litt, P.K., Kelly, A., Omar, A., Johnson, G., Vinyard, B.T., Kniel, K.E., Sharma, M. 2021. Temporal and agricultural factors influence *Escherichia coli* survival in soil and transfer to cucumbers. *Appl. Environ. Microbiol.* 87:e02418-20.

<https://aem.asm.org/content/early/2021/01/18/AEM.02418-20.abstract>

Location, season, and manure type affect survival of pathogens in in manure-amended soils. The Produce Safety Rule of the Food Safety Modernization Act (FSMA) states that untreated manure must be applied 90 or 120 days prior to the harvest of edible produce crops to minimize contamination from pathogens potentially present in untreated manure. However, this interval was not scientifically validated. Over twelve separate field trials conducted in the mid-Atlantic U.S. over four years, ARS researchers in Beltsville MD showed that spatiotemporal factors (site, year, and season) affect survival durations of *E. coli* in manure-amended soils more than agricultural factors (manure type, organic or conventional management of soils, and depth of application) or weather effects. Poultry litter frequently supported longer survival durations compared to other manure types. This work provided critical insight to vegetable and fruit growers to understand which types of raw animal manure present the most risk for produce contamination, and provided primary data to the Food and Drug Administration (FDA) for development of FSMA standards for biological soil amendments.

Reference:

Sharma, M., Millner, P.D., Hashem, F., Vinyard, B.T., East, C.L., Handy, E.T., White, K., Stonebraker, R., Cotton, C.P. 2019. Survival of *Escherichia coli* is affected by spatiotemporal, agricultural, and weather factors in the Mid-Atlantic United States. *Applied and Environmental Microbiology.* 85: e02392-18. <https://doi.org/10.1128/AEM.02392-18>

Survival of bacterial pathogens in soils amended with animal manure:

Poultry litter-amended soils enhanced survival of *E. coli*. ARS researchers in Beltsville MD performed bacterial persistence studies with non-pathogenic surrogates in soils amended with different sources of biological soil amendments (BSAs) like manure and compost in greenhouses. Greenhouse studies are a practical and economical option that could assist vegetable growers in complying with FDA recommendations on the use of BSA's without taking up valuable field space for experiments. Assessments of the effect of specific parameters (soil type, manure type, pot size) used in greenhouse studies on the survival of bacterial pathogens from manure currently are not well-documented. Regardless of pot size evaluated, soils amended with poultry litter supported the survival of *E. coli* at higher populations than unamended soils or soils amended with horse manure or dairy manure. This work showed manure type affected the survival of *E. coli* more than pot size or soil type used, and that greenhouse studies can be employed to collect practical data useful to FDA and those growers seeking variances and exceptions from FDA rules.

Reference

Sharma, M., Millner, P.D., Hashem, F., Camp, M., Whyte, C., Graham, L., and Cotton, C.P. 2016. Survival and persistence of non-pathogenic *Escherichia coli* and attenuated *Escherichia coli* O157:H7 in soils amended with animal manure in a greenhouse environment. *J Food Prot.* 79: 913 – 921. doi:10.4315/0362-028X.JFP-15-421

Organic fertilizers can affect survival durations of bacterial pathogens in soils and on leafy greens. Bacterial pathogens like *Salmonella* spp. can be introduced to produce-growing environments through contaminated irrigation water, animal intrusions, or soil/ manure runoff. Researchers at ARS in Beltsville MD showed that *Salmonella* Newport can grow to high populations in soil runoff containing heat-treated poultry pellets (HTTP), a commonly used organic fertilizer in vegetable production. Soils amended with HTTP also support longer survival durations of *Salmonella* Newport than unamended soils, and promoted more transfer of the pathogen from soils to leaves of spinach plants during the study. Soluble carbon and specific nitrogen compounds influenced survival and growth of *Salmonella* Newport. These findings provide farmers with an improved understanding of specific factors that affect and promote pathogen survival in pre-harvest produce growing environments.

Reference

Shah, M.K., Bradshaw, R., Nyarko, E., Handy, E.T., East, C., Millner, P.D., Bergholz, T.M., and Sharma, M., 2019. *Salmonella enterica* in soils amended with heat-treated poultry pellets survived longer and more readily transferred to and persisted on spinach. *Applied and Environmental Microbiology*. 85: e00334-19. <https://doi.org/10.1128/AEM.00334-19>

Methods of detection of pathogens from commercial organic composts

EMFSL scientists compared US Environmental Protection Agency (EPA) methods to U.S. Composting Council Test Methods for the Examination of Composting and Compost (TMECC). which have not been validated for use across a wide variety of composts. Our study evaluated 29 different commercial composts, made from manure, biosolids, and yardwaste feedstocks collected from across the United States. Subsamples of these products were inoculated with non-pathogenic *E. coli*, *E. coli* O157:H7, and *Salmonella* spp. The EPA method recovered significantly greater levels of fecal coliforms and *E. coli* than TMECC methods. Both methods showed equivalent recoveries of *Salmonella* spp. No single physicochemical factor was able to predict the regrowth of *E. coli* O157:H7 and *Salmonella* spp. in composts, but total organic carbon, carbon/nitrogen ratios, and moisture content were shown to contribute to regrowth of pathogens in composts.

Reference

Reynnells, R., Ingram, D.T., Roberts, C., Stonebraker, R., Handy, E.T., Felton, G., Vinyard, B., Millner, P.D., Sharma, M. 2014. Comparison of U.S. Environmental Protection Agency and U.S. Composting Council microbial detection methods in finished compost and regrowth potential of *Salmonella* spp. and *Escherichia coli* O157:H7 in finished compost. *Food Path Dis.* 11. July 2014. <https://doi.org/10.1089/fpd.2013.1698>