Development of Early Die: A Preliminary Look

Daniel Gill, Arslan Sarwar, Julie Pasche
Department of Plant Pathology, North Dakota State University

NDSU

Introduction

- Potato early die (PED) is caused by a complex of pathogens, fungi *Verticillium dahliae* and *Colletotrichum coccodes*, and root lesion nematodes in the genus *Pratylenchus*.
- PED is characterized by wilting and premature plant senescence (Figure 1). Soil fumigation is the most efficacious and utilized management strategy in the northern US.
- When soil pathogen levels are high, soil fumigation may not reduce pathogen infestation to levels below economic thresholds, leading to early die limiting yield.
- This research aims to provide further understanding of soil fumigation performance on high disease pressure fields and to elucidate the roles of *V. dahliae* and *C. coccodes* colonization under a commercial production system.

Figure 1. Potato early die symptoms of wilting and premature senescence (D. Gill 2023).

Methods

This study was conducted in 2023 in a Russet Burbank potato field in north central Minnesota with a history of potato early die disease.

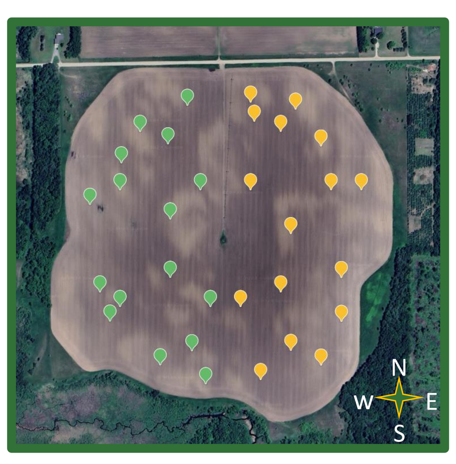
1. Commercial fall fumigation

The field was split, each half treated with commercial soil fumigation of chloropicrin (240 lb/acre) or metam sodium (40 gal/acre) in the fall prior to the potato growing season.

2. Sample locations

Locations in the field were arbitrarily established along either side (25 to 30 feet) of four irrigator tracks. 32 total sample sites were georeferenced across the field, 16 per half (Figure 2). All data and samples were collected from each georeferenced location.

Figure 2. Sixteen field sample locations from the metam sodium treatment (green pins) and 16 sample locations from chloropicrin treatment (yellow pins) (Google Earth version 9.194.0.0 (2023)).



3. Field sampling

After planting, soil samples were collected for early dying analysis (*Verticillium* propagules and plant parasitic nematode counts) by Pest Pros (Plainfield, WI). Plants were visually rated for disease at four times during the growing season (Figure 3), and stem tissue was destructively sampled from five plants per location (Figure 4). At harvest, tubers were sampled from 10 ft of one row per location (Figure 5).

Figure 3. Disease rating (D.Gill 2023).

Figure 4. Stem sampling (D.Gill 2023).

Figure 5. Harvest sampling (D.Gill 2023).

4. Molecular analysis

DNA was extracted from dried and pulverized stem tissue. A real time qPCR assay was used to quantify *V. dahliae* and *C. coccodes*. Results were normalized against an external control added to each sample during the initial steps of DNA extraction.

Preliminary Results

- *Verticillium* propagules per gram (Vppg) of soil were significantly higher for the metam sodium treatment when compared to the chloropicrin treatment. *Pratylenchus* nematodes were detected at three of 32 locations at low levels (< 12 root lesion nematodes per 100 cc soil).
- The visual development of early die in the metam sodium treatment was significantly greater than in the chloropicrin treatment from 77 to 105 days after planting (Figure 6).
- Colonization by both pathogens was higher in stems collected from the metam sodium treated half of the field when compared to the chloropicrin treated half, significantly different based on the area under the pathogen colonization curve (AUPCC) (Figures 7 to 9).
- Total yield was significantly higher with chloropicrin treatment (Figure 10).

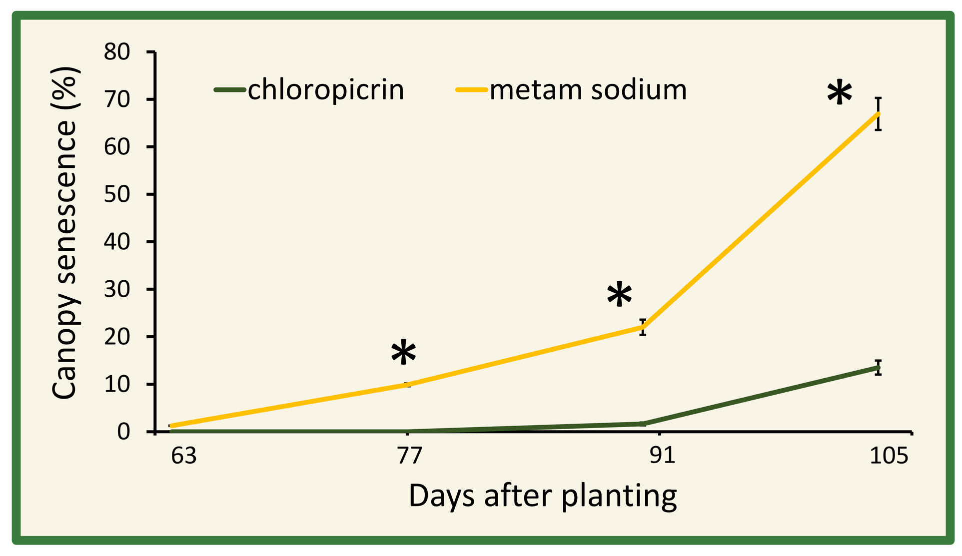


Figure 6. Visual ratings of canopy senescence during the growing season. Data 77 to 105 days after planting are significantly different as indicated by *(α = 0.05).

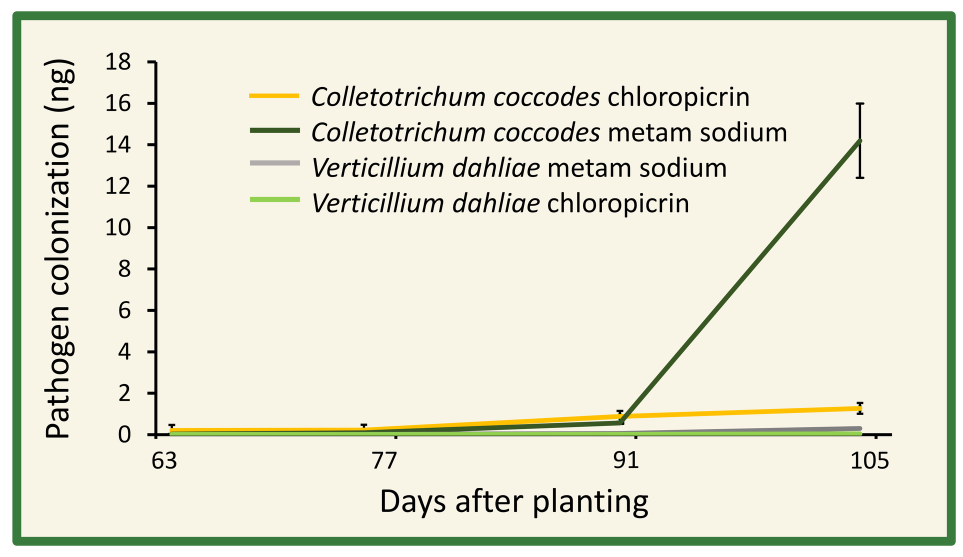


Figure 7. Mean amount of *V. dahliae* and *C. coccodes* DNA per gram of dried potato stem. Significant difference in overall colonization is displayed in figure 9.

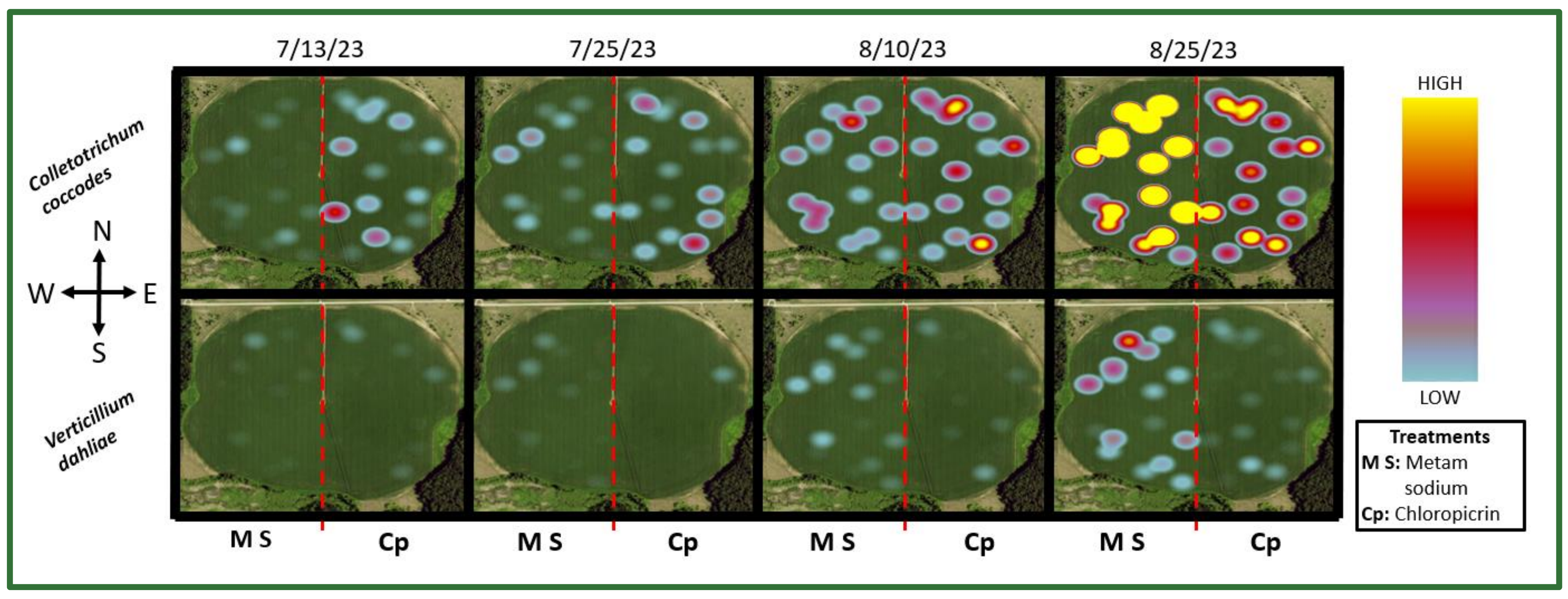


Figure 8. Heat map representation of Verticillium wilt (*V. dahliae*) and black dot (*C. coccodes*) pathogen colonization of potato stem tissue as measured by qPCR through the growing season. Increase in colonization denoted by warmth of color. The map was created using Arc GIS Pro v3.2 software and the kernel density estimation procedure.

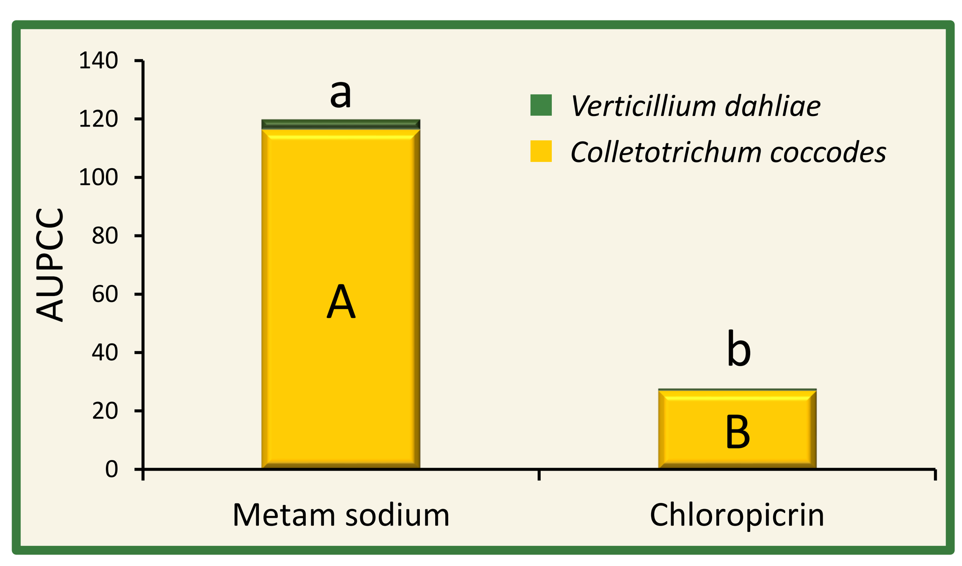


Figure 9. Area under the pathogen colonization curve (AUPCC) for *C. coccodes* and *V. dahliae* for both fumigation treatments. Differing letters denote significance (α=0.05). Upper-case letters inside bars denote significant differences between treatments for *C. coccodes* colonization. Lower-case letters above the bars indicate significant differences in *V. dahliae* colonization between treatments.

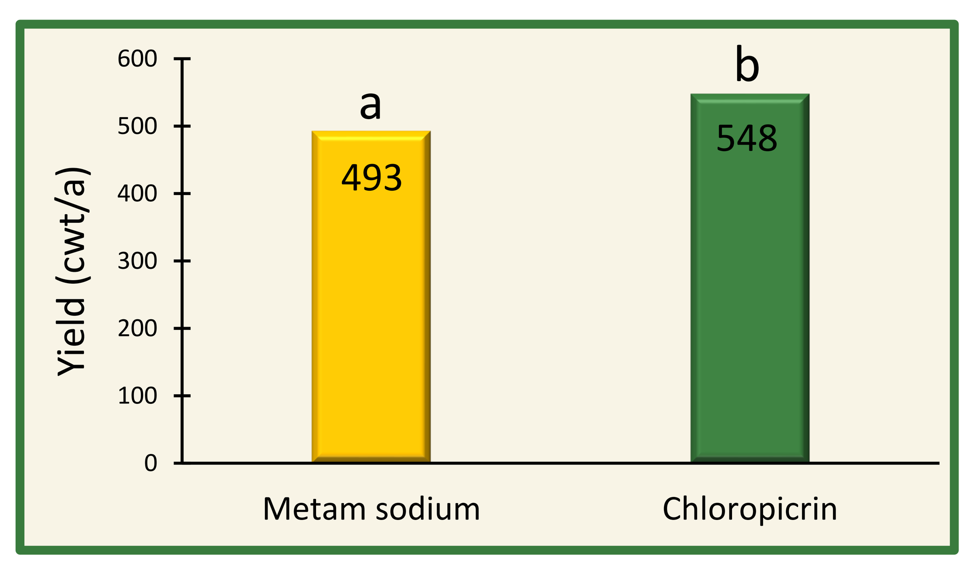


Figure 10. Total yield (cwt/a) calculated from digging all tubers from a single 10ft row at each sample location. Differing letters denote significance (α=0.05).

References:

Berlanger, I. and M.L. Powelson. 2000. Verticillium wilt. The Plant Health Instructor. DOI: 10.1094/PHI-I-2000-0801-01 Updated 2005.

Conclusion

Our preliminary data from this single split field indicates that fumigation with chloropicrin provided greater reductions in visual early die and fungal pathogen colonization, and increased yield when compared to fumigation with metam sodium.

Future Work

Replicated trials comparing russet potato cultivars commonly grown in the Midwest and fungal pathogen colonization under commercial fumigation conditions will continue during the 2024 and 2025 growing seasons utilizing funding from the ND Dept of Ag Specialty Crop Block Program (NOGA 23-390).

Acknowledgments:
Funding for this project was provided by USDA-NIFA Hatch Project ND02244, MN Area II and Northland Potato Growers Associations. Thank you to RD Offutt Farm Division and members of the Pasche pathology team.