Modeling the Impact of the Pale Cyst Nematode *Globodera pallida* on Potato yield using the SUBSTOR-DSSAT Crop Simulation Model

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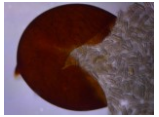
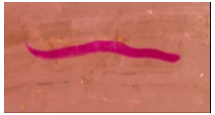


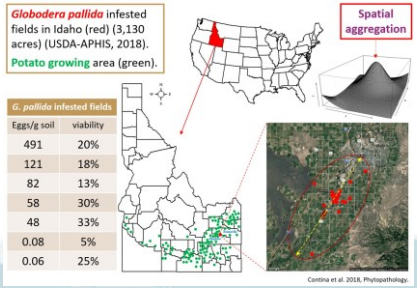


ABSTRACT

- The pale cyst nematode *Globodera pallida* is a globally regulated and quarantine potato pest in the state of Idaho.
- A risk model analysis was performed to:
  (i) determine the effect of the Idaho population of *G. pallida* on potato yield;
  (ii) estimate reproduction rate from different initial nematode densities;
  (iii) simulate potato yield losses in Idaho field conditions by integrating the coefficients of potato yield into the SUBSTOR-DSSAT crop simulation model.
- Results showed that fresh tuber weight was significantly reduced by 44% at 40 eggs/g soil and by 87% at 80 eggs/g soil in trial 1, and 29% at 40 eggs/g soil and by 38% at 80 eggs/g soil in trial 2.
- A significant increase of *G. pallida* reproduction rate was observed, reaching almost 50 times the amount of eggs initially applied in soil

INTRODUCTION

- *Globodera pallida* can survive in the soil for up to 30 years without a suitable host as a cyst containing the nematode eggs.
- SUBSTOT-DSSAT was developed to simulate potato growth under different environmental and agronomic conditions.
- This study is focused on investigating the risk of potato yield losses caused by *G. pallida* as a result of initial nematode densities using the potato growth model in the SUBSTOR-DSSAT crop simulation system.
- The main goal of this study is to inform policymakers, stakeholders and the public in general of the threats posed by *G. pallida* for the U.S. potato industry.



G. pallida infested fields

Eggs/g soil	viability
491	20%
121	18%
82	13%
58	30%
48	33%
0.08	5%
0.06	25%

MATERIALS & METHODS

- Experiments were conducted in greenhouse environment using five different level of initial nematode densities in soil (0, 10, 20, 40 and 80 eggs/g soil).
- Potato yield coefficient was calculated by comparing yields in *G. pallida* non-infested with infested soil:

$$Y_{coeff} = 1 - \left[\frac{(Y_0 - Y_n)}{Y_0}\right]$$

where, (Y_{coeff}) is the potato yield coefficient, (Y_0) is the yield in *G. pallida* non-infested soil and (Y_n) is the yield in infested soil at different levels of *G. pallida* initial nematode densities (n).

- Potato yield coefficients were integrated into SUBSTOR-DSSAT:

$$Y_{ij} = Y_i \times Y_{coeff}$$

where, (Y_{ij}) is the potential potato yield after *G. pallida* damage and (Y_i) is the potential yield without *G. pallida* damage.

RESULTS

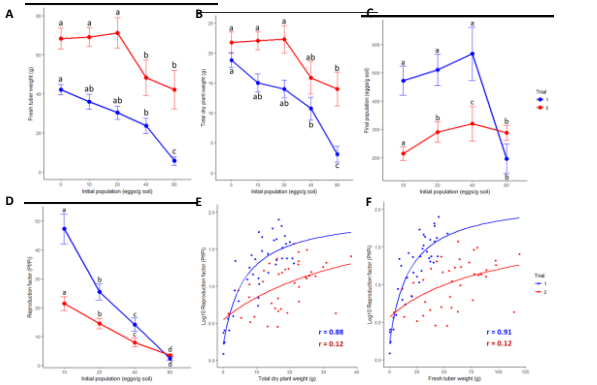


Fig. 1. Impact of initial nematode densities on: **A.** Fresh tuber weight; **B.** Total plant weight; **C.** Final nematode population in soil; and **D.** Nematode reproduction rate. **E.** Non-linear relationship between *Globodera pallida* reproduction rate vs total dry plant weight; and **F.** vs Fresh tuber weight.

RESULTS

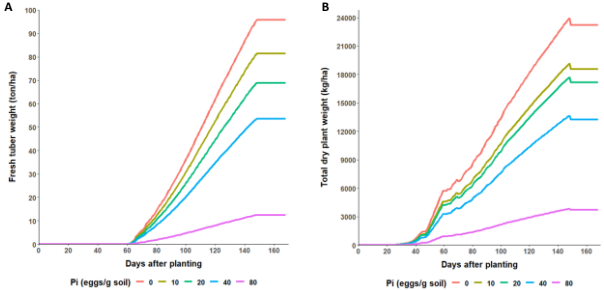


Fig. 2. SUBSTOR-DSSAT potato growth simulation coupled with the impact of *Globodera pallida* initial nematode densities on: **A.** Fresh tuber weight; and **B.** Total dry plant weight.

CONCLUSIONS

- *Globodera pallida* caused significant potato yield loss at high nematode densities in soil.
- *Globodera pallida* showed a rapid reproduction rate reaching almost 50 times the amount of initial nematode densities in soil.
- *Globodera pallida* can rapidly spread via contaminated farm equipment or plant materials in the absence of an effective biosecurity regulation.
- The enforcement of quarantine regulation in Idaho greatly contributed in restricting *G. pallida* infested fields to a small area of 3,130 acres.
- This study should facilitate common understandings between regulators, policymakers and potato growers on the challenges and opportunities for controlling this economically important pest.

References:
Contina, J.B., Dandurand, L.M., Knudsen, G.R. 2018. A spatial analysis of the potato cyst nematode *Globodera pallida* in Idaho. Phytopathology, 108: 988-1001.

Hoogenboom, G., et al. 2017. Decision Support System for Agrotechnology Transfer (DSSAT) version 4.7. DSSAT Foundation, Gainesville, Florida.

Acknowledgement:
USDA-NIFA competitive grant no. 2015-69004-23634

USDA NIFA GLOBAL Globodera Alliance POTATO EXPO AUSTIN 2019