

Relationship Between Soybean Cyst Nematode, Soil Health, and Other Edaphic Factors in Ohio

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Background

Soybean cyst nematode (SCN) is the most economically impactful, yield-limiting soybean pathogen in North America.¹ On average, producers can experience 30% yield loss with no above ground symptoms in soybean.² Little is known about how soil health and management practices influence SCN population dynamics.

Objectives

This study evaluated SCN reproductive factor (RF) in relation to:

1. Soil texture and its interaction with management,
2. Key soil physicochemical properties and seasonal changes (Δ)
3. Predictive performance of individual soil properties versus CASH soil health indices.

Predictive power of soil texture and management practices

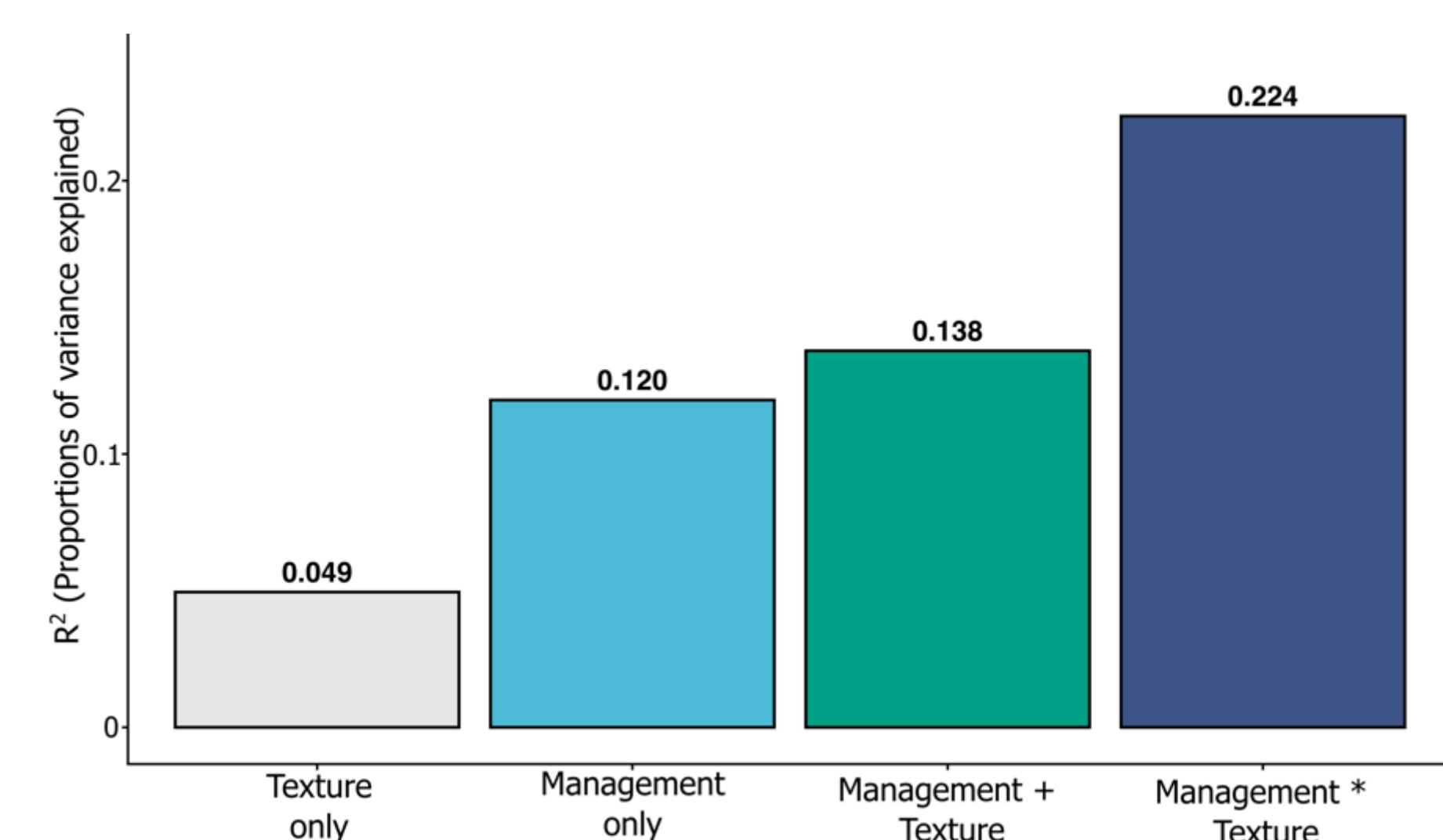


Figure 1. Model comparison showing texture alone explains only 4.9% of RF variance compared to 12.0% for management practices. Adding texture to management models provides minimal improvement, indicating soil texture has limited practical value for SCN prediction.

Relationship between CASH Biological Index and SCN RF

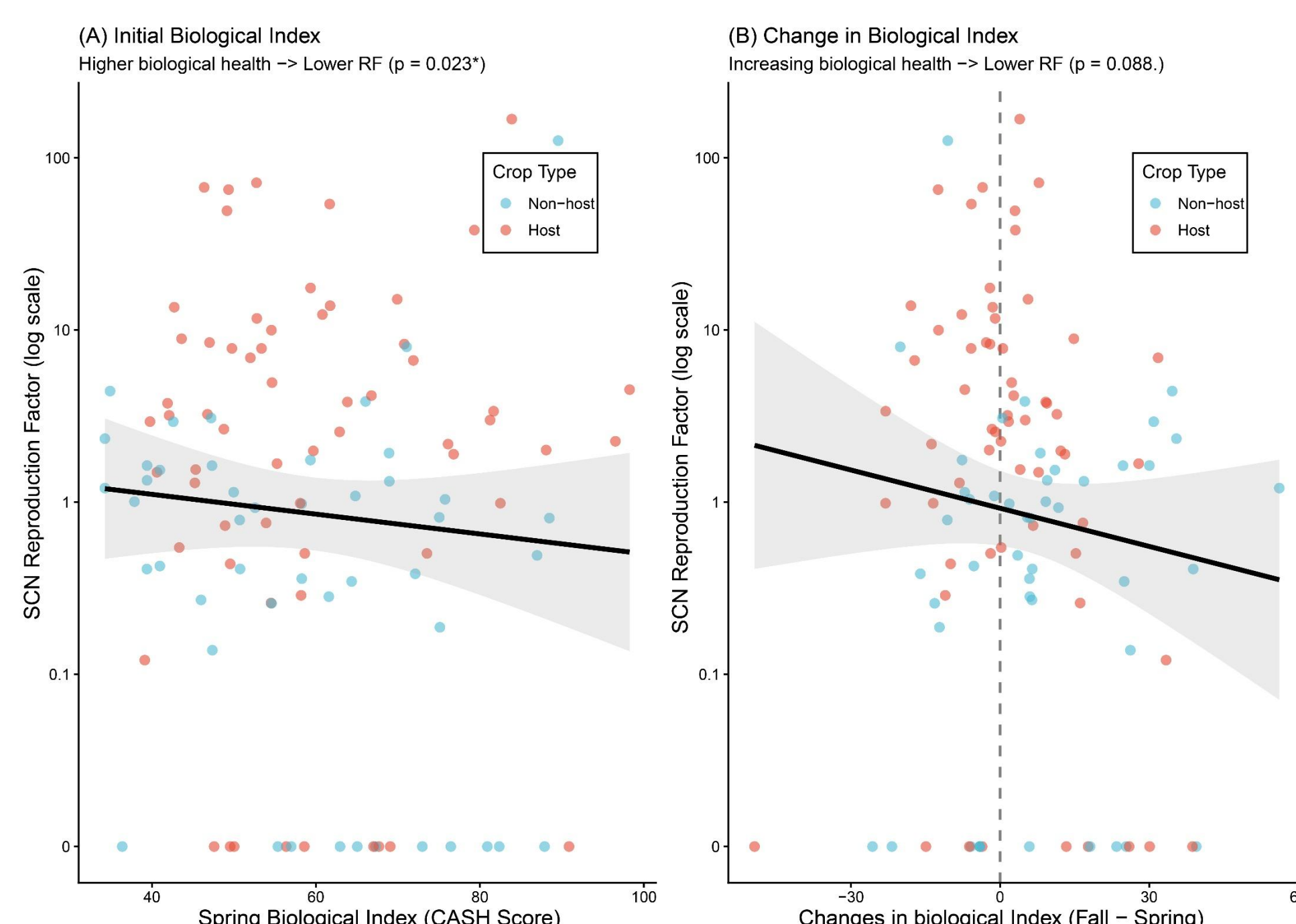


Figure 2. (A) Spring biological CASH Index versus SCN reproduction factor. Higher biological index was significantly associated with lower RF, though substantial scatter indicates weak predictive power. (B) Change in biological Index (Fall - Spring) versus RF. Seasonal increases in biological index showed marginally negative association with RF.

Crop Management Practices Regulate Soybean Cyst Nematode Population Dynamics Over Soil Health



Materials and Methods

Data Collection

- Soil health and SCN survey conducted in 2023-2024 across 27 Ohio counties with voluntary grower participation from 185 fields.
- Fields sampled twice: spring pre-plant and fall post-harvest
- Metadata collected from each participating field.
- SCN analysis and soil physical, chemical, and biological analysis at each timepoint.

Data Analysis

- Analysis performed in R 4.3.1
- SCN population modeling using zero-inflated negative binomial (ZINB) and hierarchical linear regression.
- Soil health also assessed using CASH indices with seasonal change calculated as Δ = fall – spring.

Effect sizes of significant predictors of SCN reproduction factor

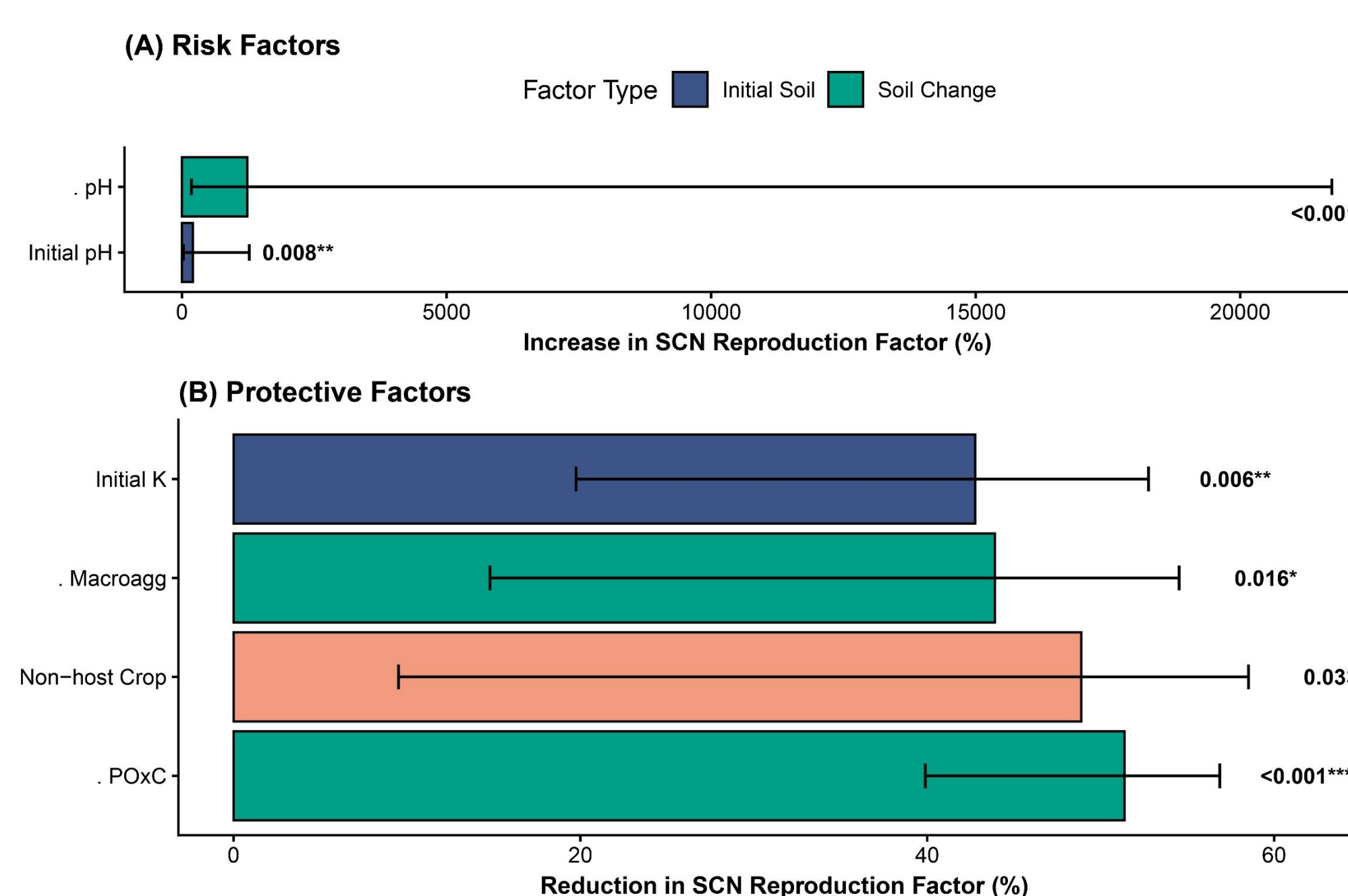


Figure 3. Horizontal bar plot showing the percentage change in SCN reproduction factor associated with a one standard deviation increase in each predictor from the full linear model. Bars are colored by factor type: initial soil properties (blue), management practices (coral), and soil property dynamics (Δ , teal). Error bars represent 95% confidence intervals; p-values are displayed for each predictor. Positive values indicate factors that increase RF, while negative values indicate decrease in RF. All displayed predictors were statistically significant ($p < 0.05$).

Results

- Soil texture explained minimal variance in RF. Crop rotation was the dominant management factor, reducing RF by 79% in non-host crops.
- Modeling revealed seven significant predictors of SCN RF:
 - Δ of POxC, pH, and macroaggregates
 - Spring measurements of K, pH, and POxC
 - Presence of non-host crops
- Individual soil property analysis explained 2.8 times more variance than CASH indices

Heat map of model performance predictive powers

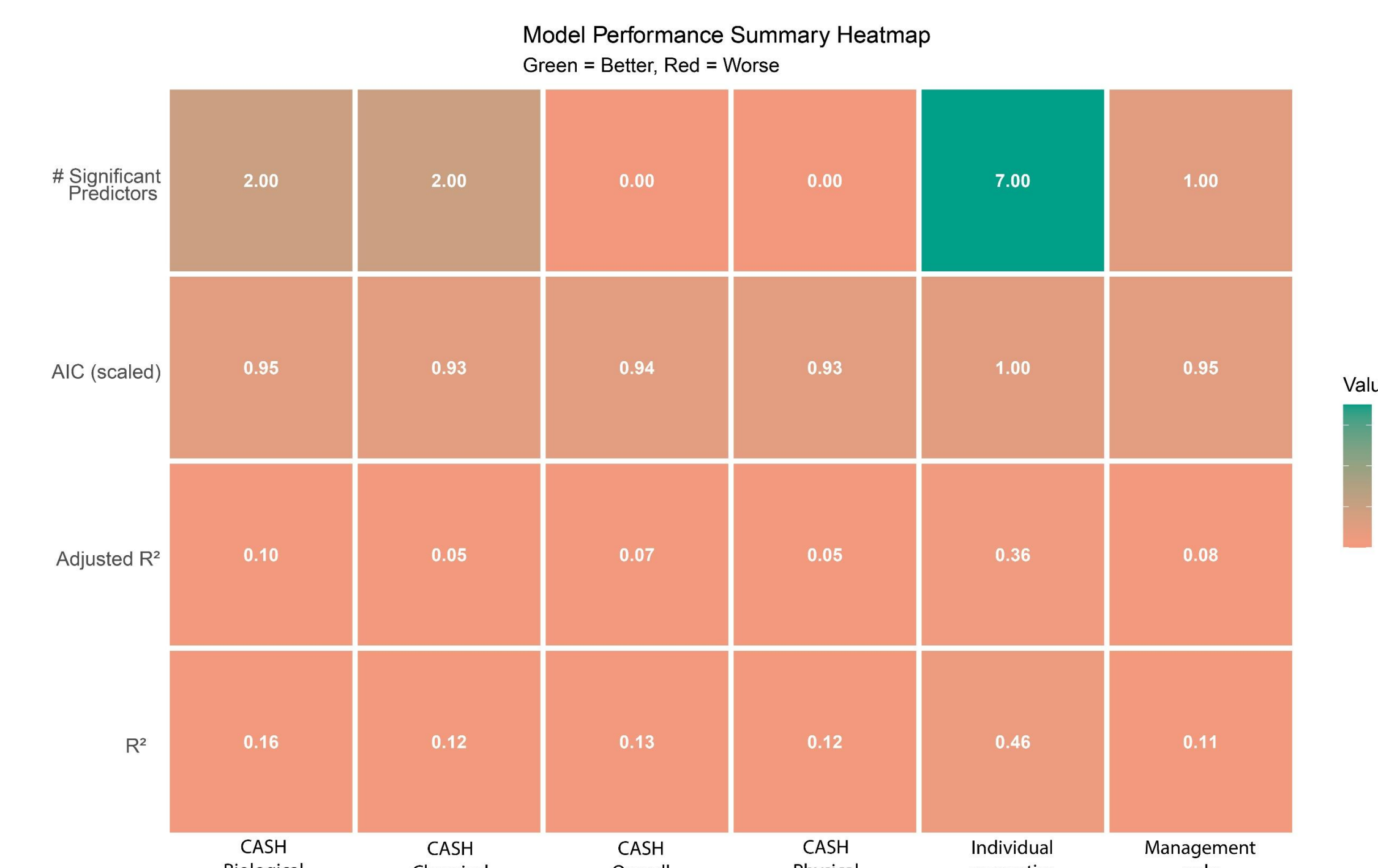


Figure 4. Heatmap showing model performance across four metrics: R², Adjusted R², AIC scaled, and number of statistically significant predictors. Color intensity indicates performance (green = better, red = worse). Individual soil properties (5th column) substantially outperformed all CASH composite indices across all metrics. All four CASH indices performed similarly, with performance comparable to the management-only baseline, demonstrating that composite soil health scores provide minimal added value for SCN prediction.

Conclusions

- Crop rotation, diversified genetics, and continued SCN monitoring are crucial for balancing soil health objectives with pathogen suppression in grain production systems
- CASH assessment predictive power of individual factors. Individual property assessment is a more reliable method of modeling contributing factors influencing SCN population dynamics.

Literature

1. Niblack, T.L. 2005. Soybean cyst nematode management reconsidered. *Plant Disease* 89(10):1020-1026. Doi: <https://doi.org/10.1094/PD-89-1020>.
2. Wang, J., T.L. Niblack, J.A. Tremain, W.J. Wiebold, G.L. Tylka, C.C. Marett, G.R. Noel, O. Myers, and M.E. Schmidt. 2003. Soybean cyst nematode reduces soybean yield without causing obvious aboveground symptoms. *Plant Disease* 87(6):623-628. Doi: 10.1094/PDIS.2003.87.6.623.

Acknowledgements

We would like to thank the Ohio Soybean Council for their financial contributions to this project. Additionally, this research would not be possible without the coordination efforts of Elizabeth Hawkins and Jason Hartschuh, and the efforts of all Ohio extension educators and growers.



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