How do growers respond to host resistance? A conditional Gaussian Bayesian network for causal inference of fungicide cost savings

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Abstract

The damage potential of crop disease is tremendous, and growers may require optimal fungicide input to save money from the Hop powdery mildew incidence caused by *Podosphaera macularis*. The economic value of disease resistance has been researched for a long time, but how increasing host resistance saves on input costs is multifaceted and nuanced. We draw upon a comprehensive data set of the incidence of hop plants with powdery mildew collected from commercial hop yards in Oregon from 2014 to 2017 and associated production meta-data, and grower pesticide application records to understand how host resistance to hop powdery mildew influences the cost of fungicide inputs. We used Bayesian networks, which allowed us to identify a framework of the idiosyncratic elements of the motivating pathosystem. They identified high levels of host resistance could reduce the annual costs of fungicides. Furthermore, another important insight from our finding was in the types of fungicides used, shifting from relatively expensive synthetic fungicides or mixtures thereof to lesser expensive non-synthetic fungicides. This switching behavior may happen across cultivars, even those with relatively high levels of host resistance. We also found out how the annual costs of fungicides change with seasonal mean disease incidence depending on the specific susceptibility to (non)R6-virulent strains through the simulations studies. Our findings hint at several potential strategies for switching pesticide use and costs for managing powdery mildew on hop. We also highlight the utility of Bayesian networks for simultaneously understanding the multifaceted interaction of several factors for causal inference in observational studies.

Commented [DG1]: Points to make:

1. High levels of resistance needed to substantially reduce pesticide costs in this crop
2. How increasing host resistance saves on input costs is nuanced. Cost savings vs. spray savings: changes in interval and slight delay in first spray, but real savings are due to choice of pesticide
3. Tension between reductions in spraying/costs and the level of resistance needed. Imperative to consider durability Approach provides a framework for understanding causality for complex, multivariate problems