Abstract

Methods for causal inference from observational data are common in human disease epidemiology and social sciences but are used relatively little in plant pathology. We draw upon an extensive data set of the incidence of hop plants with powdery mildew (caused by *Podosphaera macularis*) collected from yards in Oregon from 2014 to 2017 and associated metadata on grower cultural practices, cultivar susceptibility to powdery mildew, and pesticide application records to understand variation in and causes of growers' fungicide use and associated costs. An instrumental causal forest model identified growers' spring pruning thoroughness, cultivar susceptibility to two of the dominant pathogenic races of *P. macularis*, network centrality of yards during May–June and June–July time transitions, and the initial strain of the fungus detected as important variables determining the number of pesticide active constituents applied by growers and the associated costs they incurred in response to powdery mildew. Exposure-response function models fit after covariate weighting indicated that both the number of pesticide active constituents applied and their associated costs scaled linearly with the seasonal mean incidence of plants with powdery mildew. Although the causes of pesticide use intensity are multifaceted, biological and production factors collectively influence the incidence of powdery mildew, which has a direct exposure-response relationship with the number of pesticide active constituents that growers apply and their costs. Our analyses point to several potential strategies for reducing pesticide use and costs for management of powdery mildew on hop. We also highlight the utility of these methods for causal inference in observational studies.