Do Online Pest Management Courses Change Grower Behavior? Powdery Mildew and California Grape Growers.

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OVERVIEW

Holders of Restricted Material Application Certificates in California are required to obtain a certain amount of continuing education credits prior to certificate renewal. Over two hundred courses are available to the growers, and many courses promote Integrated Pest Management (IPM) models to guide pest and disease management. These courses are potentially an important tool in optimizing pesticide applications by growers in response to a disease outbreak. However, little is known about the effect of such courses on grower behavior in practice.

This paper explores the effect of an online training course on grower pesticide application behavior and the resulting environmental effects. We combine data on growers who took the online course titled "Grape Powdery Mildew Control in California Vineyards" between 2004 and 2011 with Pesticide Use Reports (PUR), Powdery Mildew Index (PMI) data, and Pesticide Use Risk Evaluation (PURE) indicators to assess the impact of the course on grape growers' pesticide applications and their environmental risk score.

The goal of our analysis is to determine whether (and how) growers change their pesticide application strategies in response to the specific guidelines covered by the online course and to evaluate the environmental impact of these changes.

DATA

Daily multi-year panel dataset of plot-level pesticide applications, powdery mildew disease risk pressure and environmental risk scores.

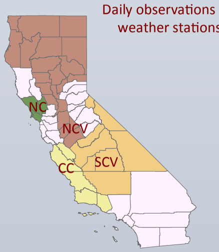
1. **Course taker sample and control group**

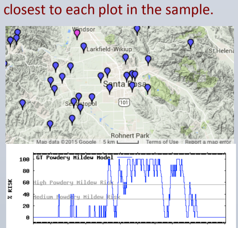
   California Department of Pesticide Regulation PUR Database: Daily plot-level pesticide applications since 1990

	Course Takers			Control Group		
	Permits	Plots	Sprays	Permits	Plots	Sprays
NC	31	168	62,065	2,052	5,939	412,849
CC	165	797	207,110	807	3,022	304,346
NCV	96	634	141,765	928	3,494	328,845
SCV	237	1,780	273,393	5,314	16,906	1,573,939

2. **Daily Powdery Mildew Pressure Forecast**

   Daily observations of Powdery Mildew Index (PMI) from weather stations closest to each plot in the sample.





3. **Environmental Impact**

   Pesticide Use Risk Evaluation Indicator (PURE) risk values linked to each plot

MODEL AND IDENTIFICATION STRATEGY

- Identification Problem: self-selected sample of course takers
- Control sample of plots near the course taker plots from the PUR database shows baseline differences in PM treatment strategies between course taker and control samples
- Propensity score matching model for the pooled sample
- Difference-in-difference, linear response function
- Year, region and plot-level fixed effects

$$S_{ijdt} = \lambda_t + \delta_j + \beta_0 PMI_{ijtd-5} + \beta_1^{post}(Z_{it} \times PMI_{ijtd-5}|L) + \beta_2^{post}(Z_{it} \times PMI_{ijtd-5}|M) + \beta_3^{post}(Z_{it} \times PMI_{ijtd-5}|H) + \phi X_{jdt} + \gamma N_{it} + \varepsilon_{ijdt}$$

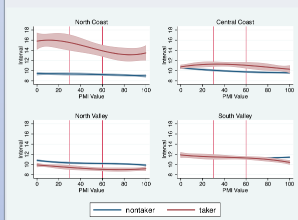
S_{ijdt} - outcome of interest; i - individual grower; j - plot; d – day; t – year; λ_t - time fixed effects; δ_j - plot fixed effects; Z_{it} - course completion dummy; X_{jdt} - plot characteristics at time of spray (prior treatment); N_{it} - grower characteristics

RESULTS

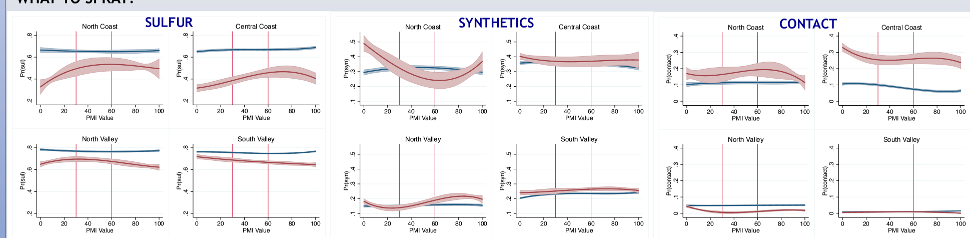
$$S_{ijdt} = \lambda_t + \delta_j + \beta_1 PMI_{ijtd-5} + \beta_1 PMI_{ijtd-5}^2 + \beta_1 PMI_{ijtd-5}^3 + \phi X_{jdt} + \gamma N_{it} + \varepsilon_{ijdt}$$

- Cubic response function
- Results presented graphically
- Analysis of private benefits to growers from completion of online course along three dimensions of adjustment:
  - Application Timing
  - Choice of Chemical
  - Chemical Dosage

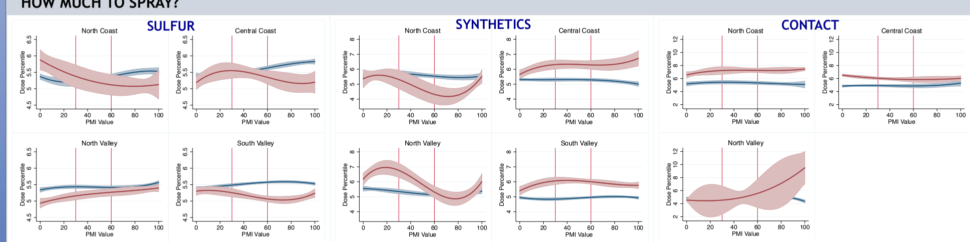
WHEN TO SPRAY?



WHAT TO SPRAY?



HOW MUCH TO SPRAY?



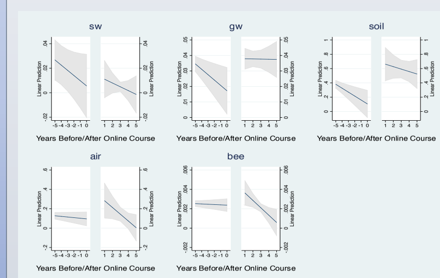
ENVIRONMENTAL IMPACT

The Pesticide Use Risk Evaluation system (PURE) was developed at the Department of Land, Air and Water Resources at UC Davis. It combines information on pesticide properties (toxicity) with environmental conditions to evaluate the risk from pesticide use on a specific field with respect to five dimensions of the environment: groundwater, surface water, soil, air and bees (Zhan and Zhang, 2012)

We use an event-study model to examine the changes in annual per acre environmental risk scores for each of the five environmental dimensions: surface water, groundwater, air, soil and bees.

$$PURE_{ijt}^k = \lambda_t + \delta_j + \beta_1^{post} Z_{it} + \beta_2^{post2} Z_{it} + \gamma N_{it} + \theta_i + \varepsilon_{ijt}$$

k - Dimension of the $PURE$ score (surface water, groundwater, soil, air, bees); Z - course completion indicator; λ_t - year fixed effects; δ_j - region fixed effects; θ_i - plot fixed effects.



CONCLUSIONS

Growers adjust their pesticide applications according to the guidelines, but with significant heterogeneity among the different production regions.

Growers tend to spray at longer intervals after the completion of the course, but they frequently increase the dosage for synthetic fungicides and contact materials. In addition, growers are more likely to spray synthetics post-class, especially during high disease pressure. The increase in dosage along with the increase in the number of chemical categories used is likely a response to the guidelines on resistance management, which is a significant part of the course. Finally, our analysis suggests that the completion of the course has a negative aggregate effect on groundwater and soil, and, in some regions - on air and bees as well.

Online PM management course has an effect on grower behavior that is generally consistent with the course recommendations, but the content of the course and targeting of the audience are critical in achieving a specific behavioral response.