

# The grape powdery mildew conundrum: fungicide selection and timing

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# Outline

- ▶ Grape powdery mildew
  - Life cycle
  - Management
- ▶ Fungicide application timing
- ▶ Field mobility assessment

Pinot Noir in  
the Willamette  
Valley, OR

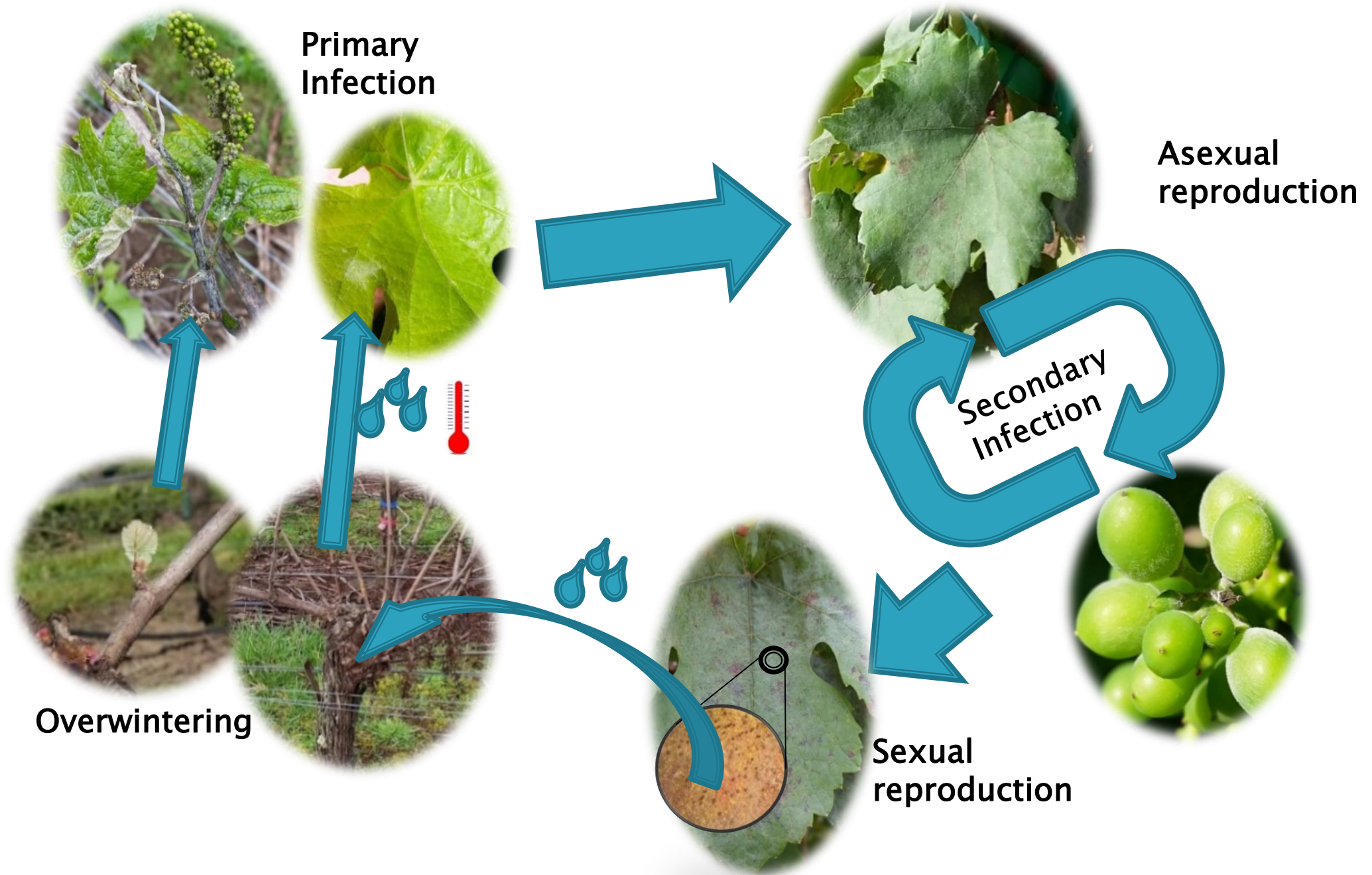




# Grape Powdery Mildew (*Erysiphe necator*)







# GPM Management

- ▶ Little natural resistance present in *V. vinifera*
- ▶ Fungicides have been used successfully for 150 years
- ▶ Typically applied on a calendar schedule

Sulfur  
dusting in  
Fresno, CA  
1972



Gene Daniels, EPA



Bordeaux mixture c. 1903  
Fr.wikipedia



# Fungicide Phenological Timing



Primary  
Infection

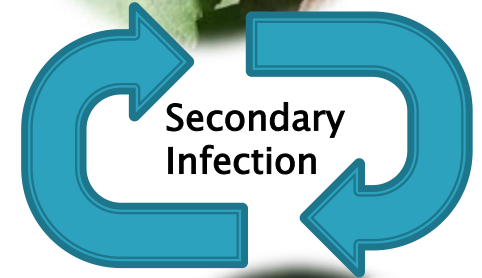


Flowering and early cluster development

Timing applications to critical fruit  
development stages increases  
disease control efficiency



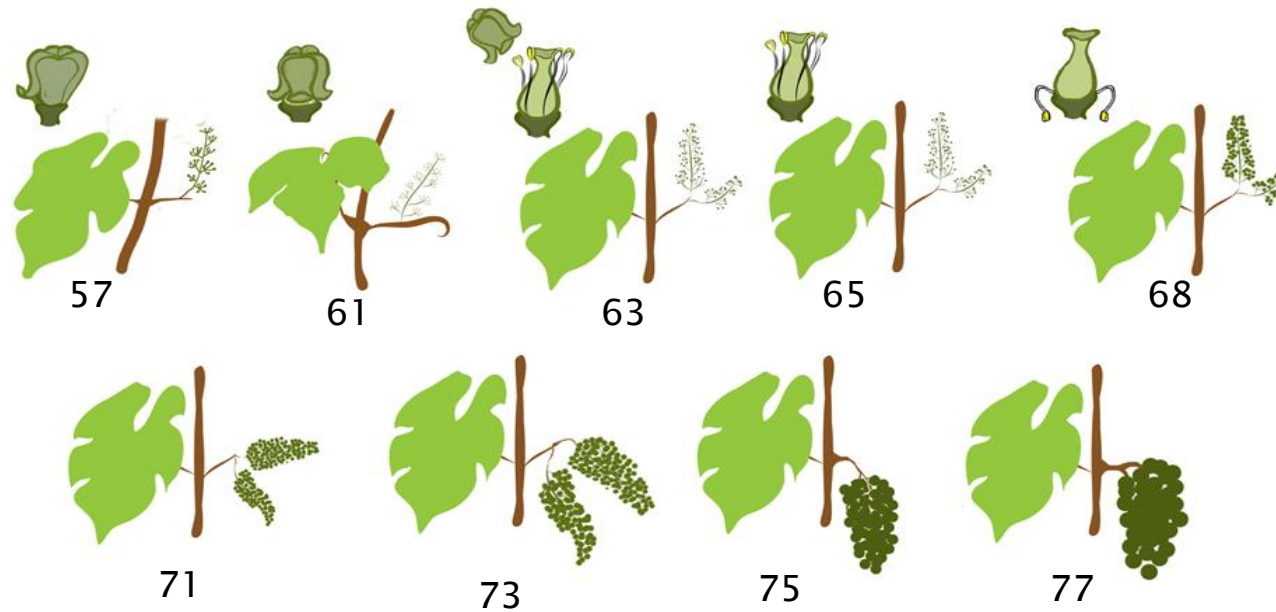
Secondary  
Infection



# Managing Fruit Infection

## ► Motivations

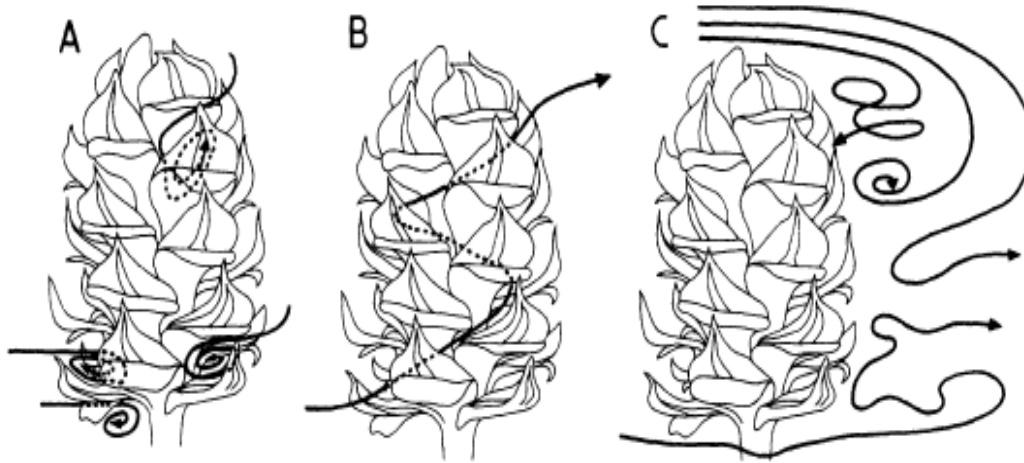
- We often find disease on inflorescences or clusters
- Various products claim mobility to unprotected tissues



Graphics of the BBCH  
phenological scale  
(Lorenz et al., 1995)



# Cluster Architecture



**Figure 4.** Air turbulence directing pollen into the cone between scale-bracts (A) and over the scale-bracts (B), and eddy formation redirecting airflow onto the leeward side of the cone. Image Credit: K. Niklas (27)





# Objective

Determine the most effective fungicide application timing with relation to grape inflorescence phenological stage



# Experimental Design

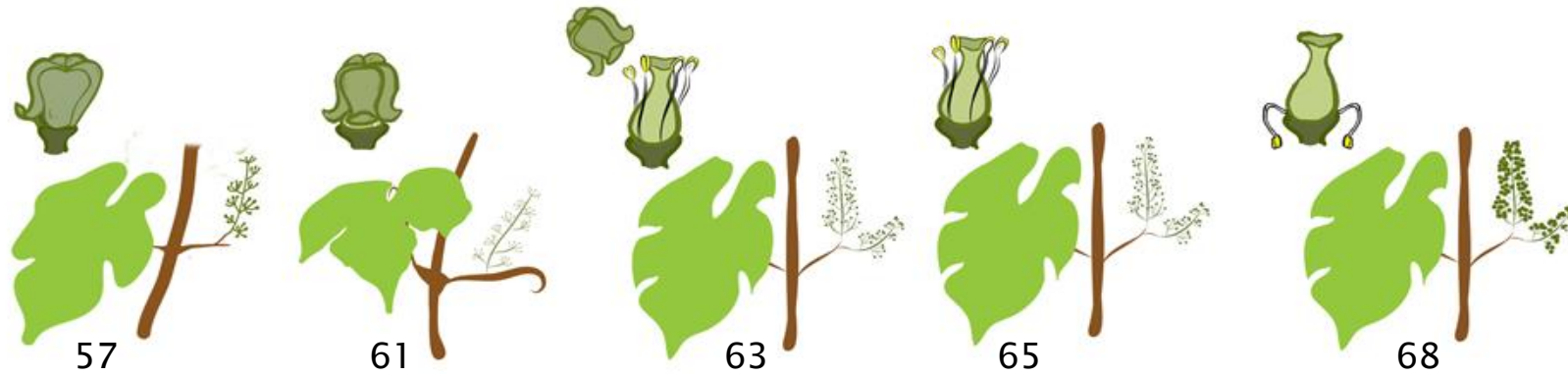
- ▶ 3x5 factorial
  - 3 flowering stages
  - 5 fungicides
- ▶ Randomized complete block design
- ▶ Weekly leaf incidence assessments
- ▶ Berry incidence assessed prior to veraison



# Fungicides

Fungicide	FRAC Group	Activity	Rate per acre
Quinoxifen	13	xylem mobility and volatilization	4 fl oz
Tebuconazole	3	xylem mobile	4 oz
Fluopyram	7	locally systemic	4 fl oz
Trifloxystrobin	11	locally systemic	2 oz
Sulfur	M2	non-systemic, volatilization	3 lb

# Application Timing



Inflorescence  
elongation  
BBCH 55



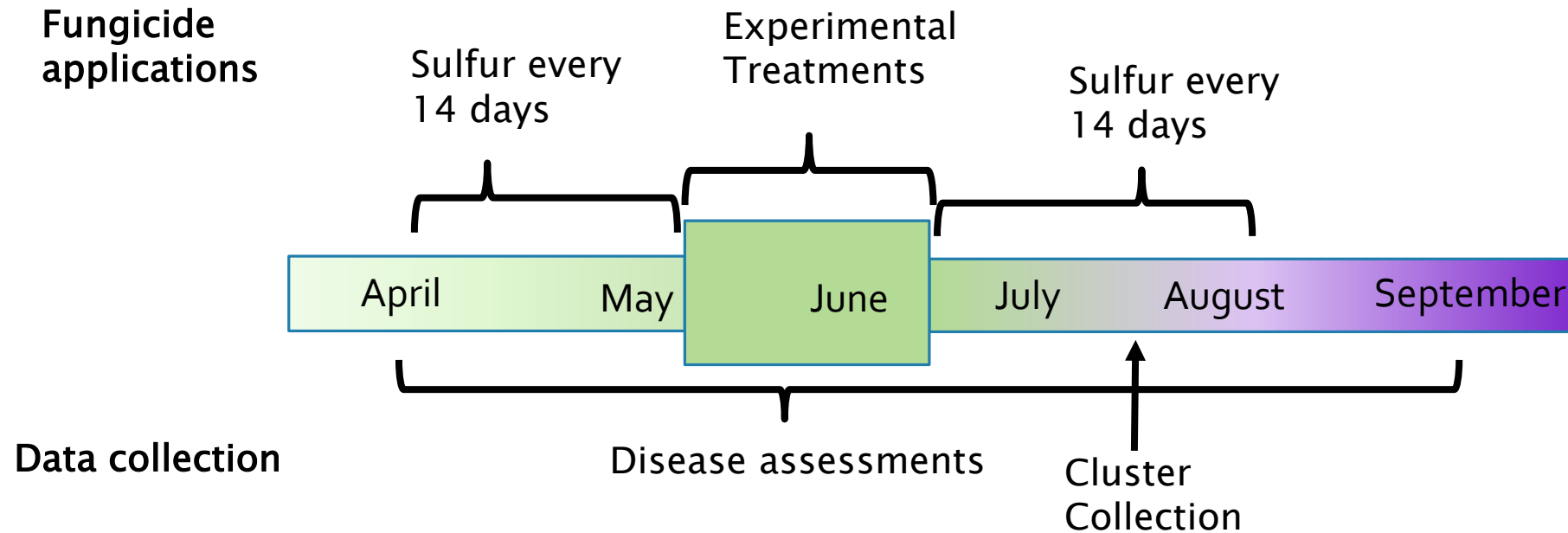
50% Bloom  
BBCH 65



Berry set  
BBCH 69



# Experiment Timeline



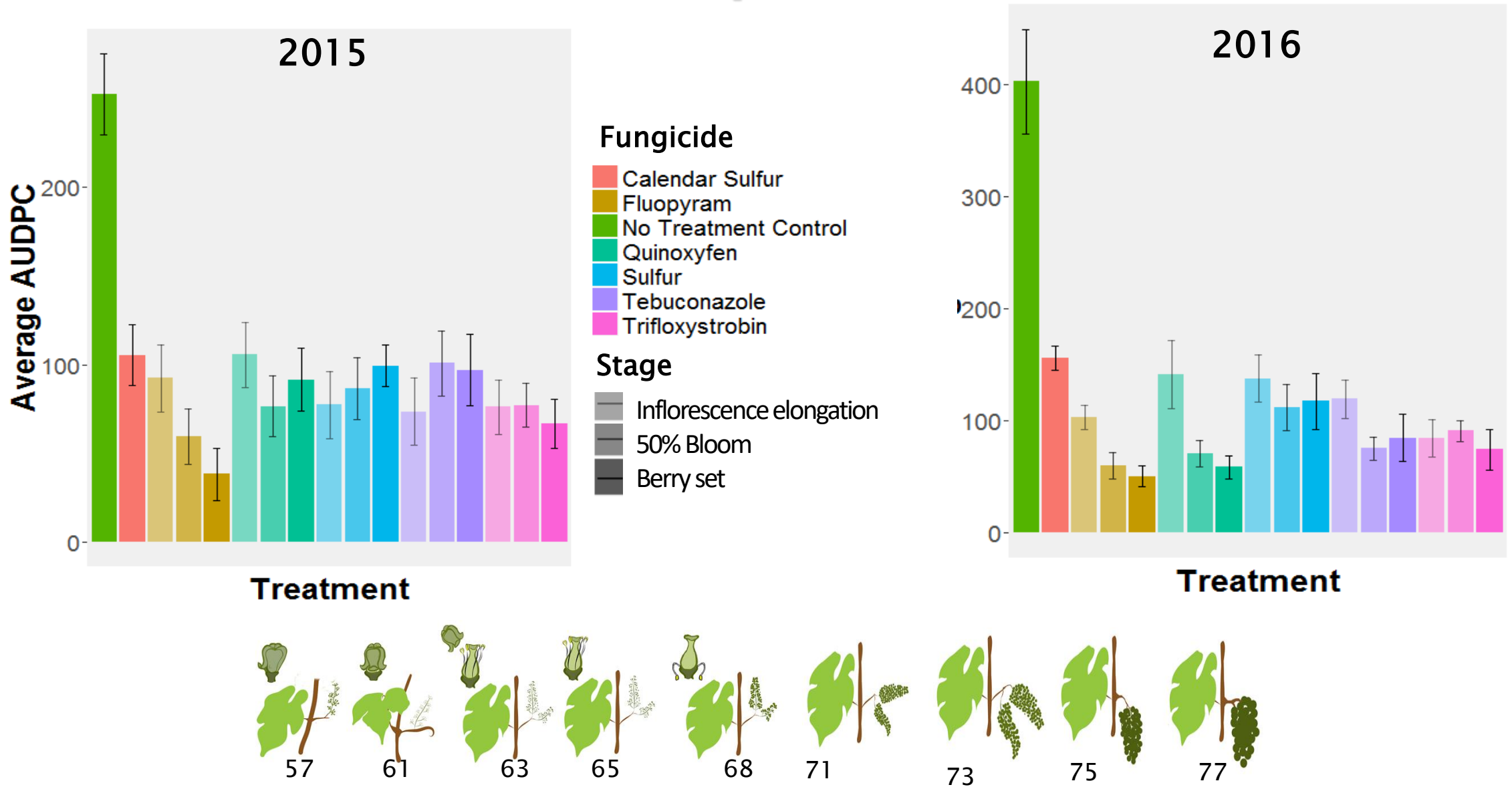


# Results

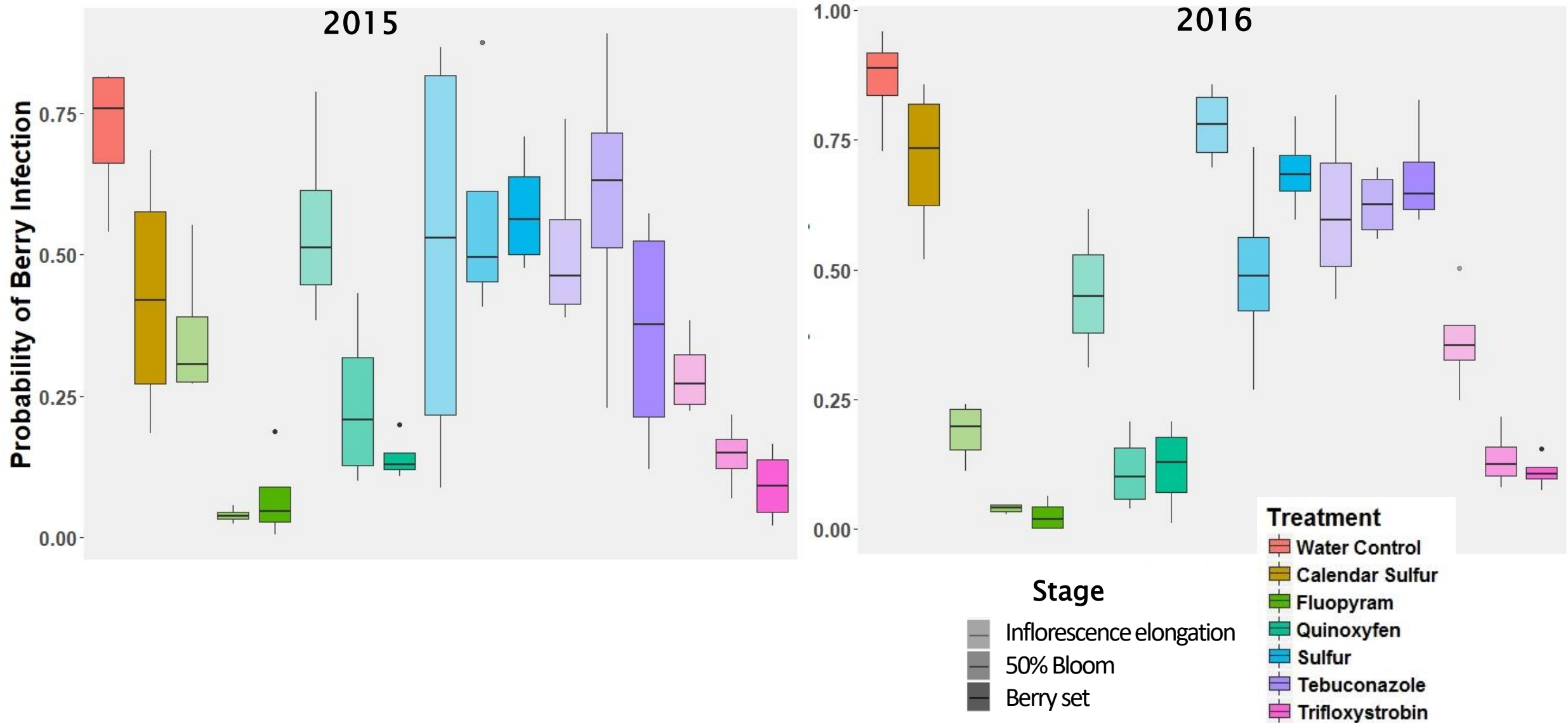




# Leaf Disease Development



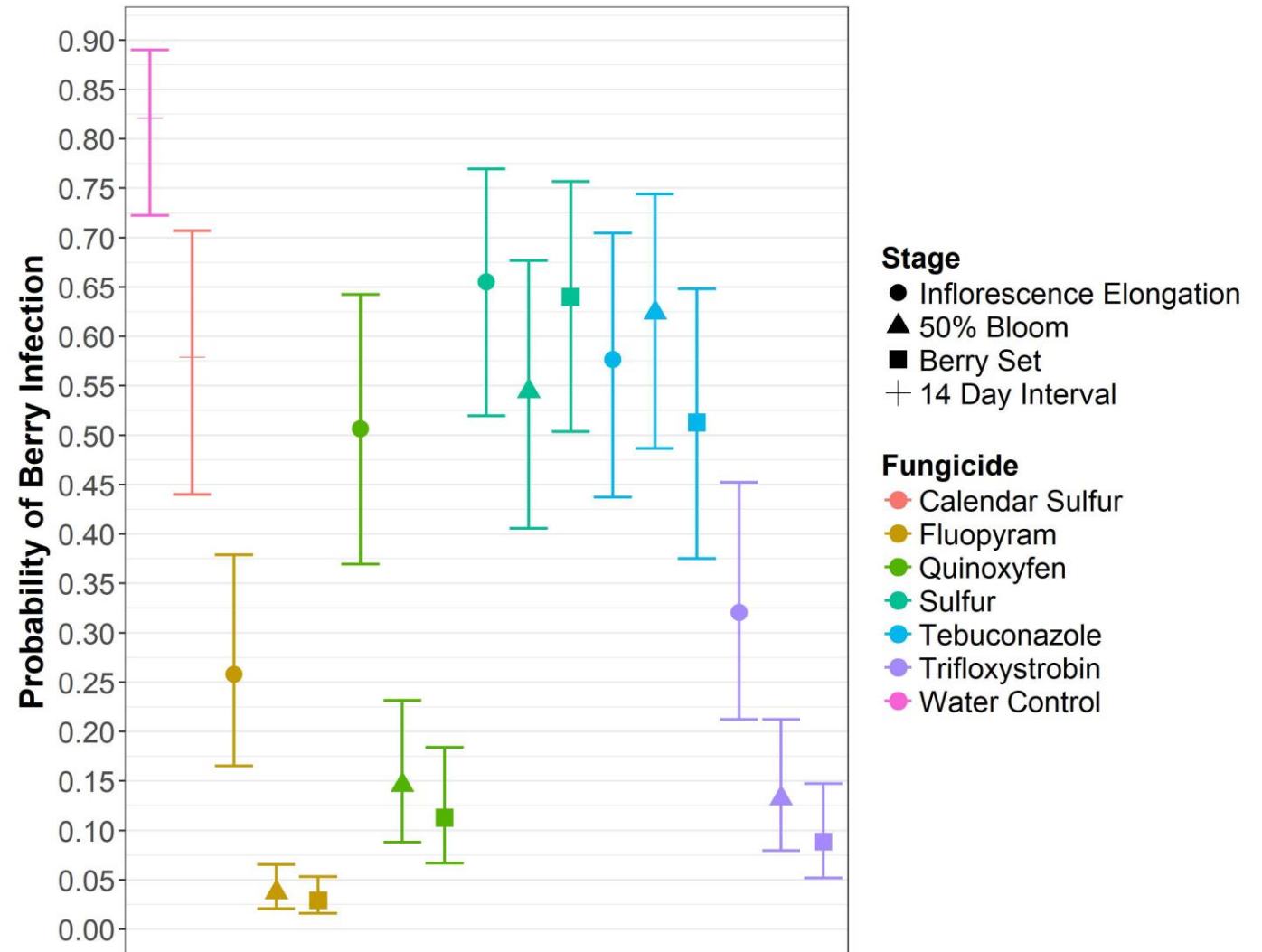
# Berry Disease Development





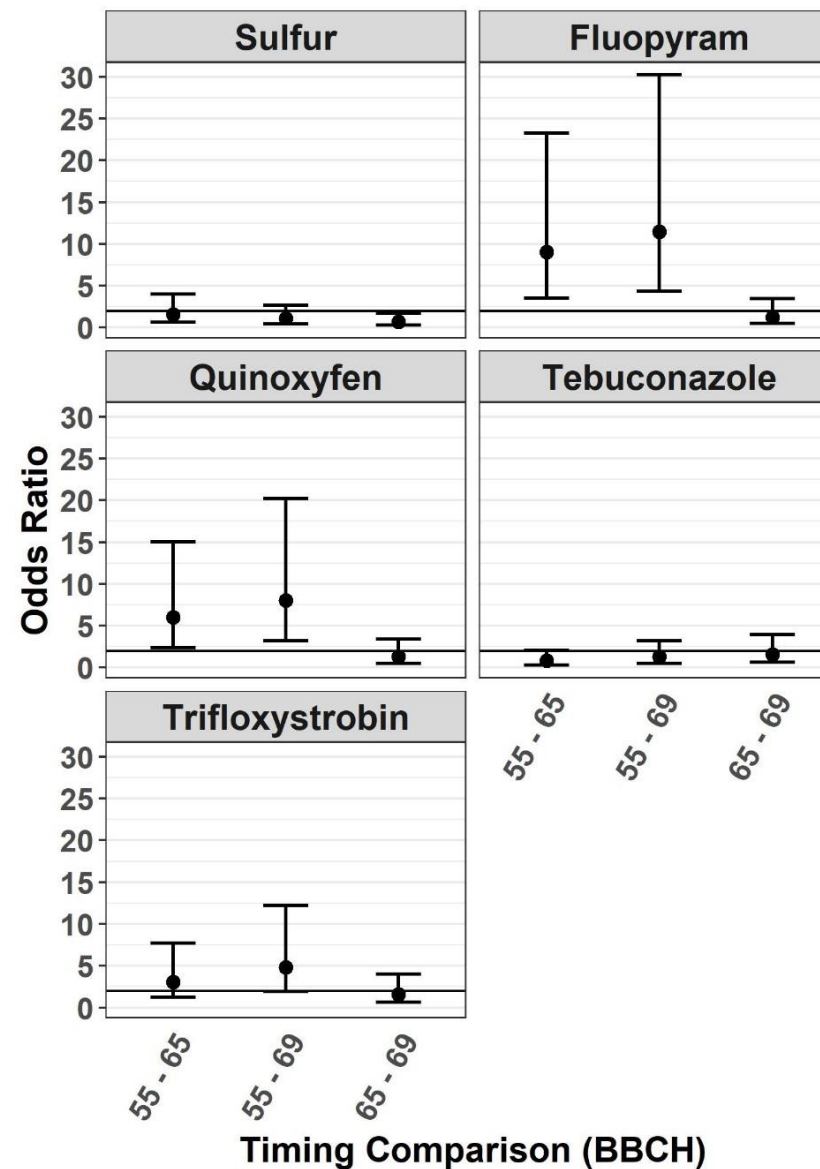
# Berry Disease Development Averaged Across Years

- Bars are 95% confidence intervals
- Points are the mean probability of berry infection



# Timing – Odds Comparison

- ▶ The bold horizontal line is at 1, indicating no difference between the two timings compared
- ▶ In general later timings were more effective





# Field Mobility Assessment

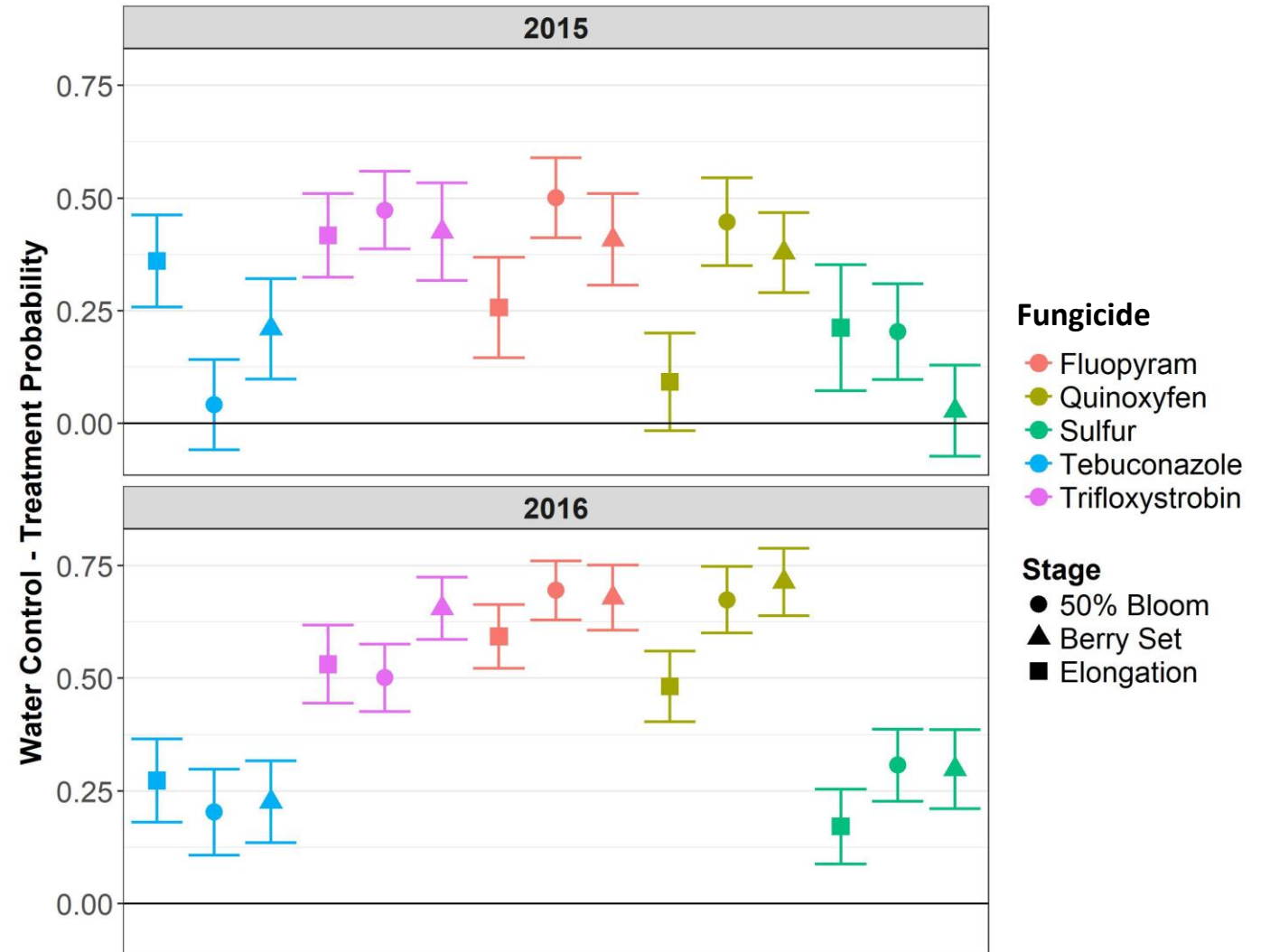
- ▶ 40 clusters per treatment were marked with ribbon
- ▶ During application clusters were covered with plastic bags
- ▶ These clusters were expected to have as much disease as the water control since they received no direct spray



Plastic bags covering clusters during an application

# Field Mobility Data

- ▶ Difference in the probability of infection between the water control and the bagged cluster
- ▶ Most of the treatments showed some protective activity
  - Vapor movement





# Phenological Experiment Summary

- ▶ Fluopyram, quinoxifen, and trifloxystrobin were most efficacious when applied later in bloom
- ▶ All five fungicides tested appeared to be mobile in the field
  - Vapor movement

Applegate Valley  
Chardonnay,  
Southern Oregon





# Current Work – Commercial Implementation

- ▶ Using the concepts of fungicide mobility and application timing to efficiently control powdery mildew on grape berries in a commercial setting





# Acknowledgements

- ▶ Foliar Pathology lab

- Walt Mahaffee
- Tara Neill
- Lindsey Thiessen
- Carly Allen
- Bailey Williams
- Katelynn Thrall
- Chris Gorman
- Andy Albrecht

- ▶ OSU Botany farm

- Steve Clusky

- Funding Source

- Oregon Wine Board

- Collaborators

- Jason Tosch, Stoller Family Estate
- Ashley Lindsay, Willamette Valley Vineyard





# Questions or Comments?





# References

- ▶ Lorenz, D. h., Eichhorn, K. w., Bleiholder, H., Klose, R., Meier, U., & Weber, E. (1995). Growth Stages of the Grapevine: Phenological growth stages of the grapevine (*Vitis vinifera* L. ssp. *vinifera*)—Codes and descriptions according to the extended BBCH scale†. *Australian Journal of Grape and Wine Research*, 1(2), 100–103. <https://doi.org/10.1111/j.1755-0238.1995.tb00085.x>