Controlling Ice Nucleating Bacteria As A Vineyard Frost Protection Strategy

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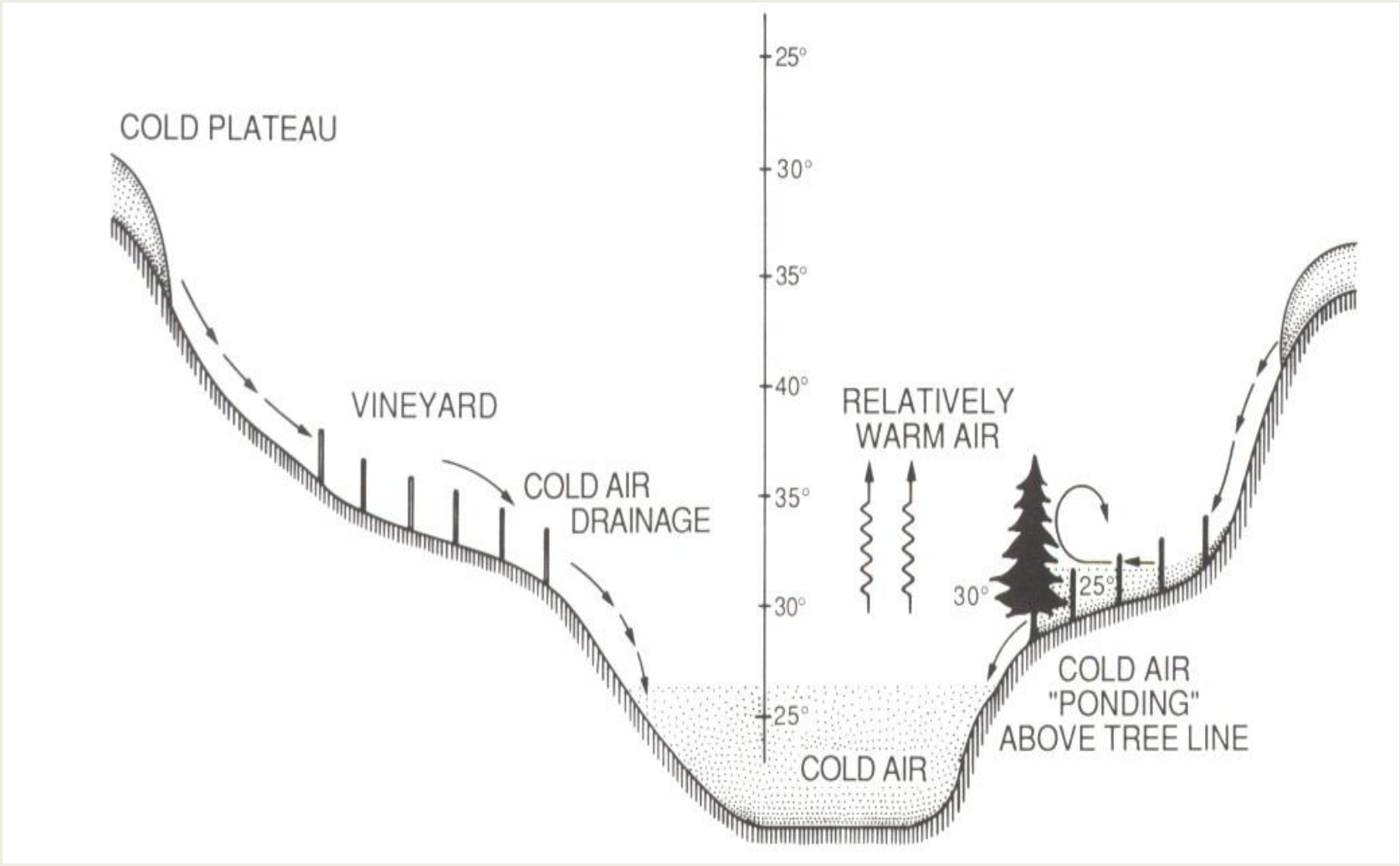
Lake and Mendocino Counties

UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Radiation Frost

- Occurs when nights are clear, and heat radiates from the earth
- Air is stratified, with coolest air close to the ground, and the air is usually still
- If warm air is 10-50 feet above the ground, it is possible to mix the air with fans
- These frost events are frequently mild, and usually above 27 ° F

Site Selection: Cold Air Flow



Advective Freeze

- This is caused by a large cold air mass, usually accompanied by wind and low humidity
- The air may actually become colder with elevation
- These freezes can be very cold, going down to 21° F
- These can cause more damage than radiation frosts because active protection measures are not effective
- Only sprinkler frost control will work

Wind Machines Protect to 27° F

Sprinklers Work to 23° F

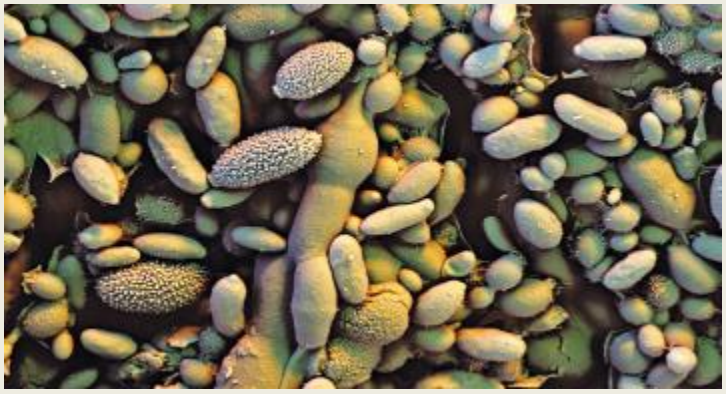
Frost and Vineyard Floor Management

Ground Preparation	Temperature Change
Bare, Firm, Moist Ground	Warmest
Shredded Cover, Moist	0.5 ºF cooler
Low Cover, Moist Ground	1 to 3 ºF cooler
Dry, Firm Ground	2 ºF cooler
Freshly disked, fluffy	2 to 3 ºF cooler
High cover crop	2 to 4 ºF cooler
High cover crop, restricted air drainage	6 to 8 ºF cooler

Wilbur Reil, Yolo & Solano Tree Crops Advisor, retired

Why Do Some Shoots Freeze But Not Others?

Phyllosphere, Plant Surfaces

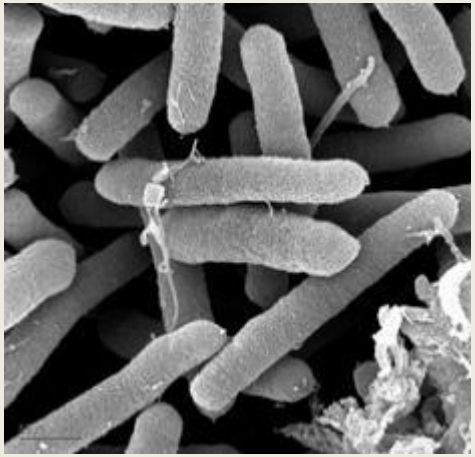


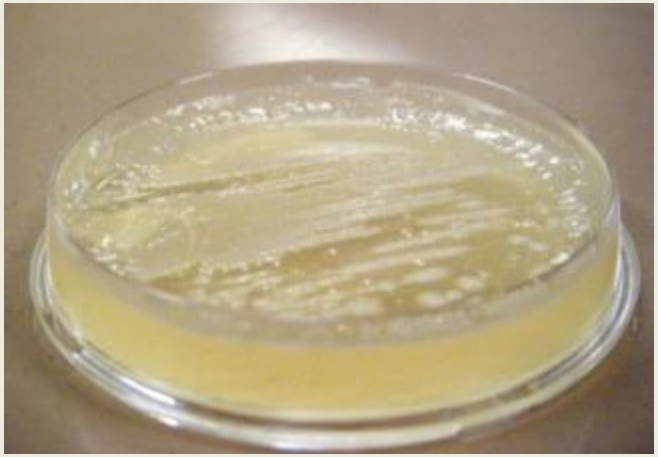
Samoray et al, 2016

Phyllosphere of Grape Vines

- Generally, grape vine leaves don't seem to support large numbers of diverse species, or populations
- Ice nucleating bacteria affect freezing, research ongoing on controlling populations
- Bacteria most likely migrate from cover crops

Ice Nucleating Bacteria





Ice Nucleation Active Bacterial Species

Pseudomonas syringae

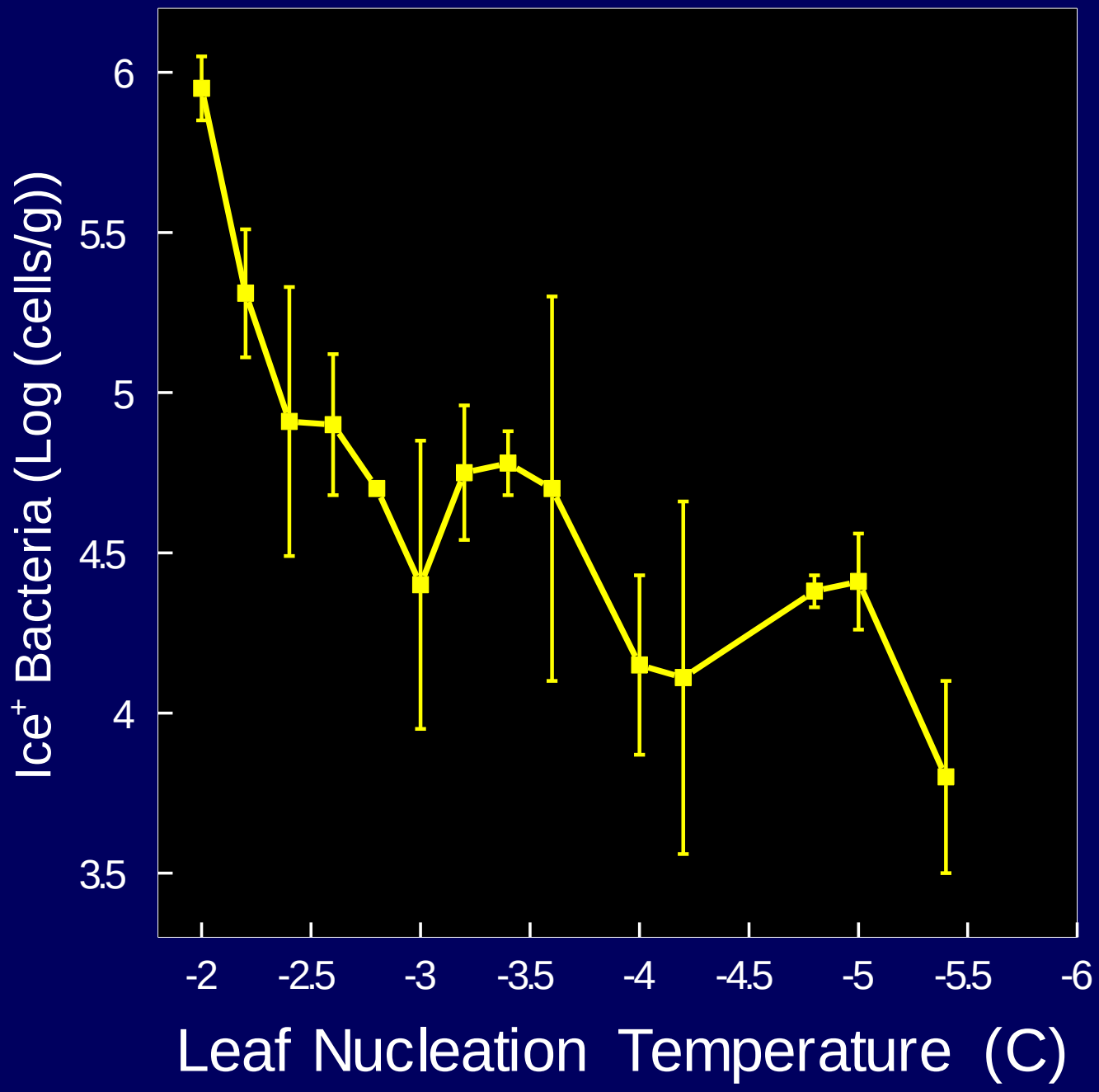
Erwinia herbicola (Pantoea agglomerans)

Pseudomonas viridiflava

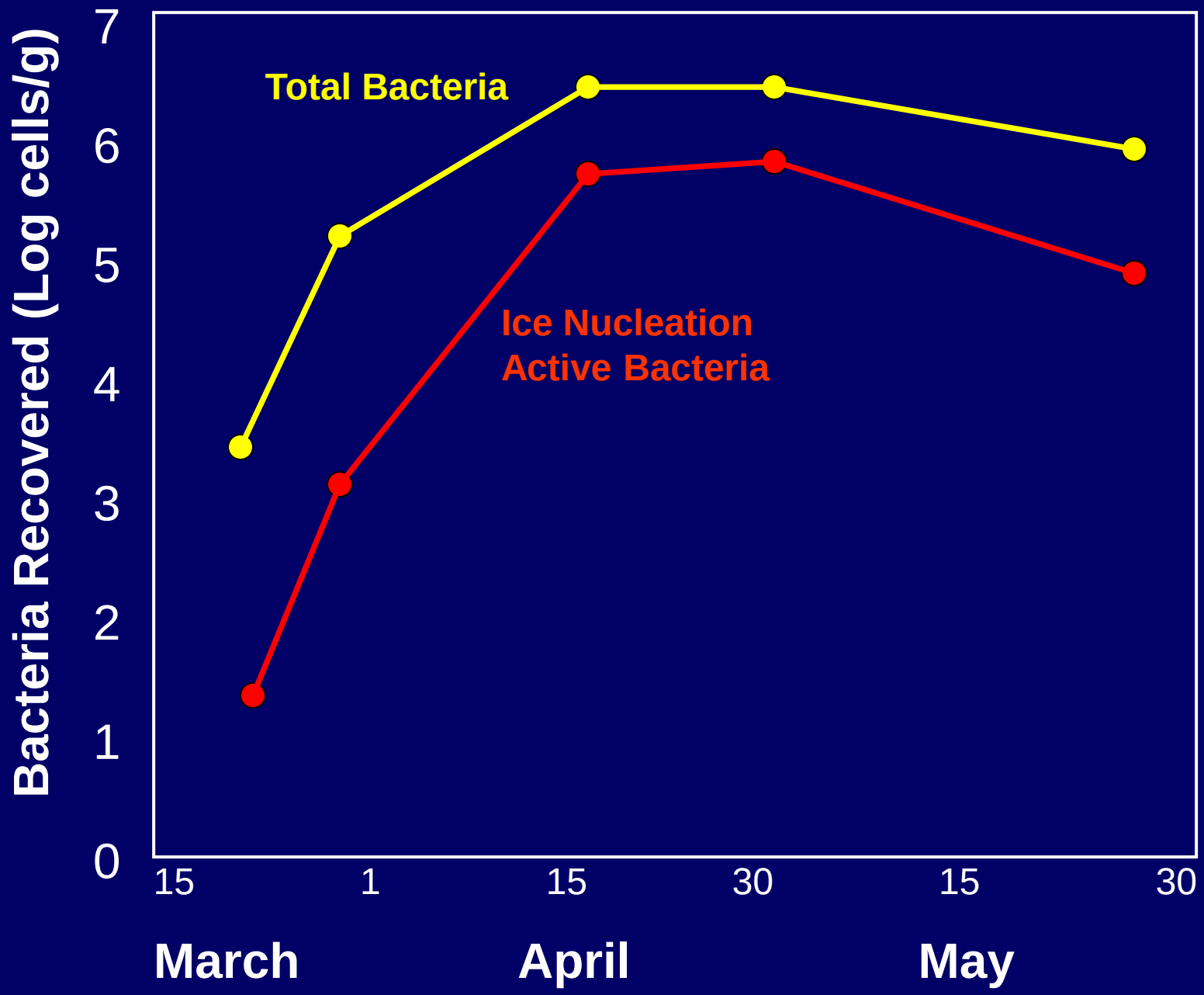
Pseudomonas fluorescens

Xanthomonas campestris pv. translucens

Bacteria Limit Plant Supercooling



New plant tissues usually initially harbor very few bacteria



Total bacterial populations on various cover crop species in early spring

Treatment	Bacteria recovered
Fine Fescue	8.26 a
Crimson Clover	8.02 a
Vetch	7.76 ab
Burr Clover	7.12 bc
Subclover	6.86 cd
Pea	5.84 ef
Grape	About 4.0


ALDER
SPRINGS
VINEYARD
ROW FIVE
2011 • MARSANNE • VIOGNIER

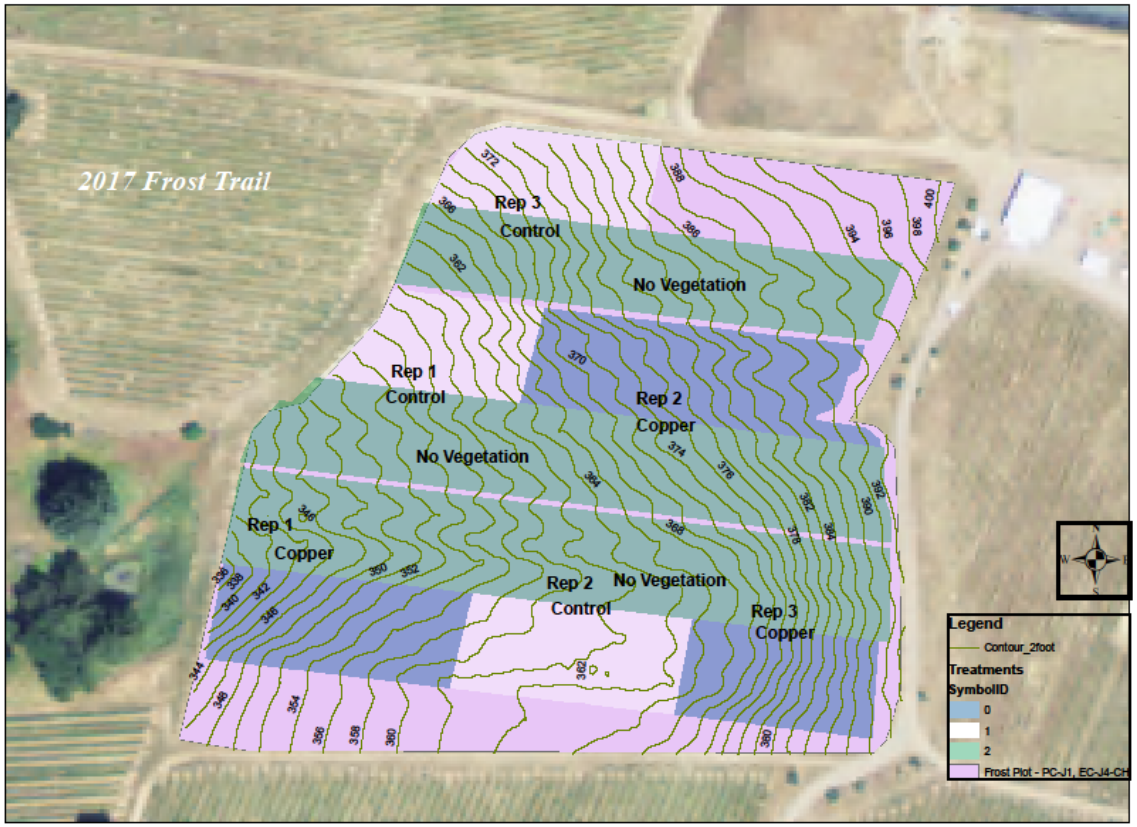
Understanding and Controlling Ice Nucleating Bacteria to Prevent Frost

Specialty Crop Block Grant # 47

October 2016-March 2018

UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Roederer Estate US Plot



Herbicidal cover crop removal 2018 & 2019

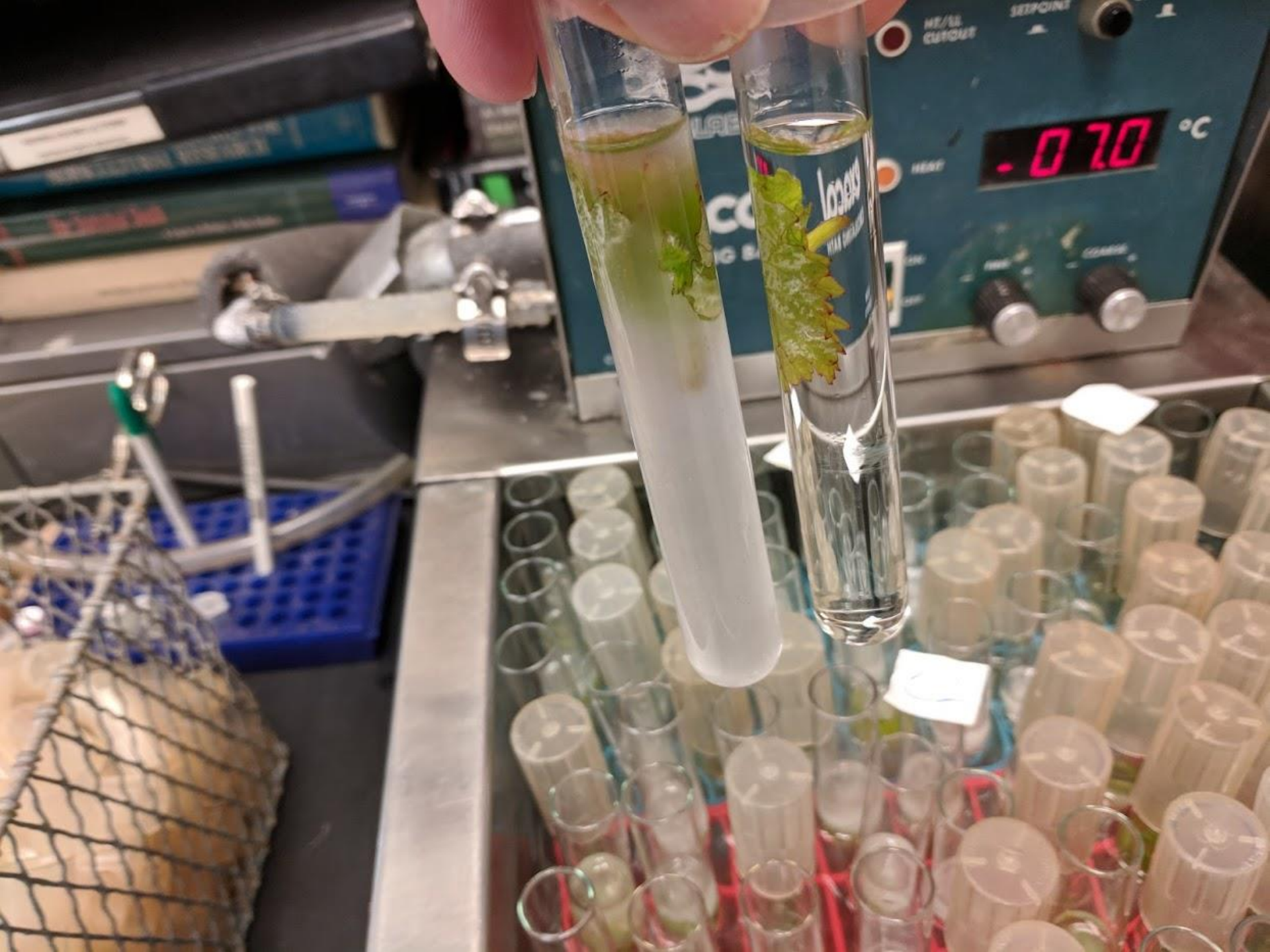
Weather monitoring

Data logger, 4 per sub plot

Weather Station

Treatments and Samples

- Cupric hydroxide: 0.75 lbs/ acre
- Spray volume: 25 gallons per acre
- Approximately 4 sprays about 10 days apart
- 20 shoots or leaves sampled per plot weekly during frost season
- Air deposition plates: 4 per plot, opened for 4 hours, done 2 times during the trial


HI/LO CUTOUT
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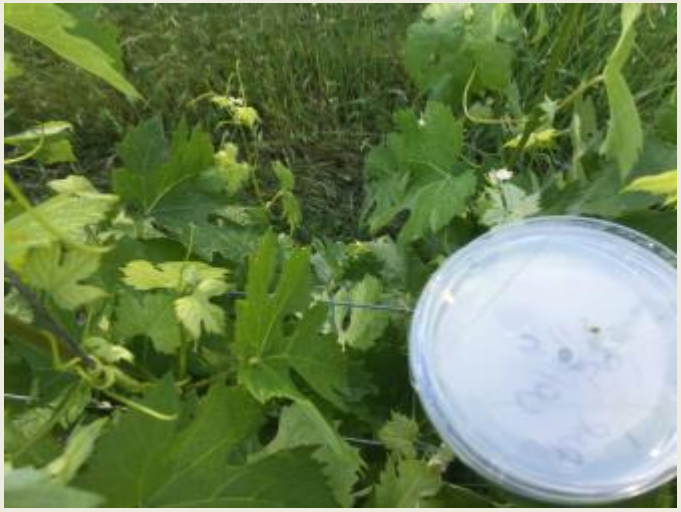
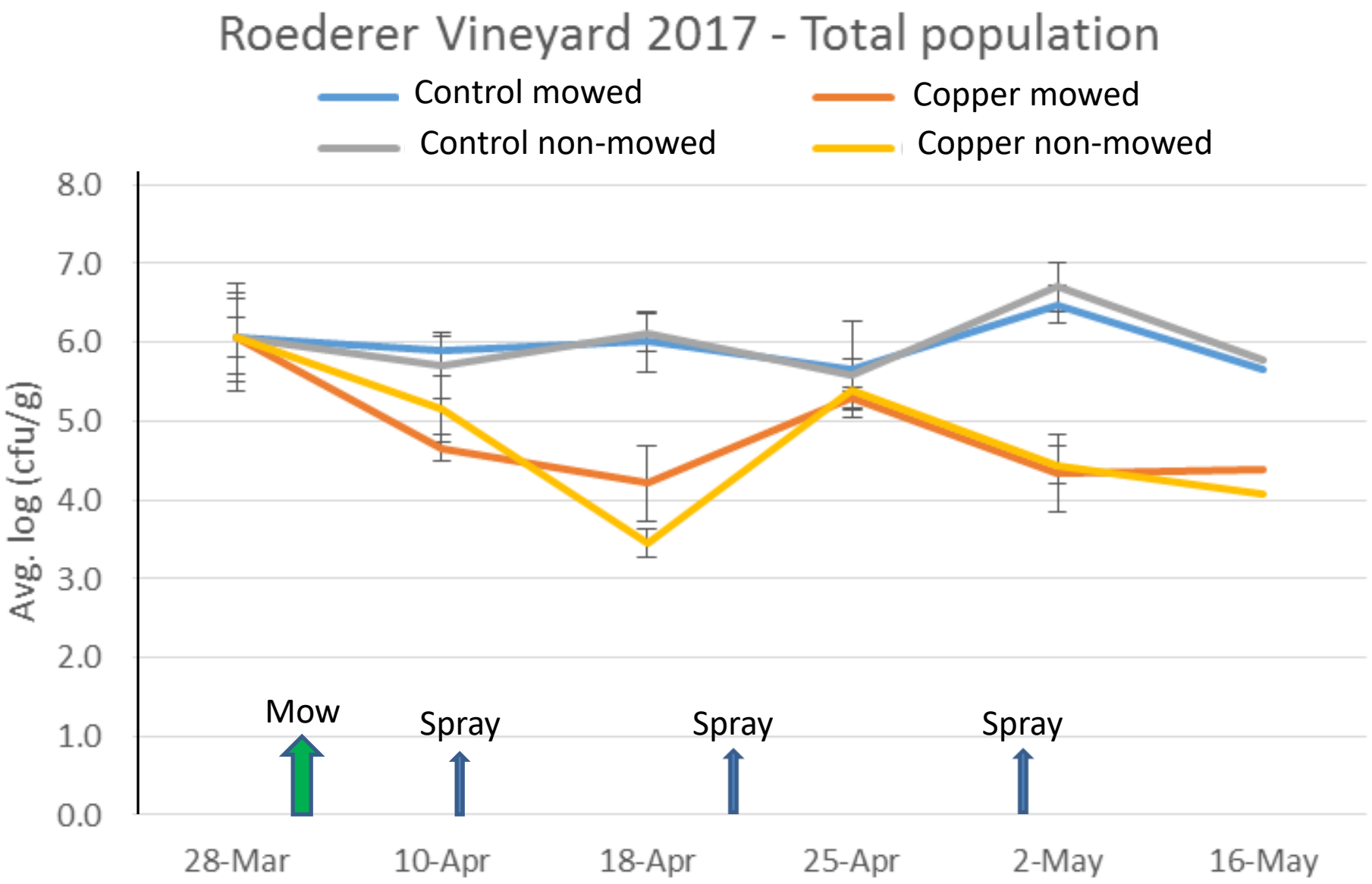
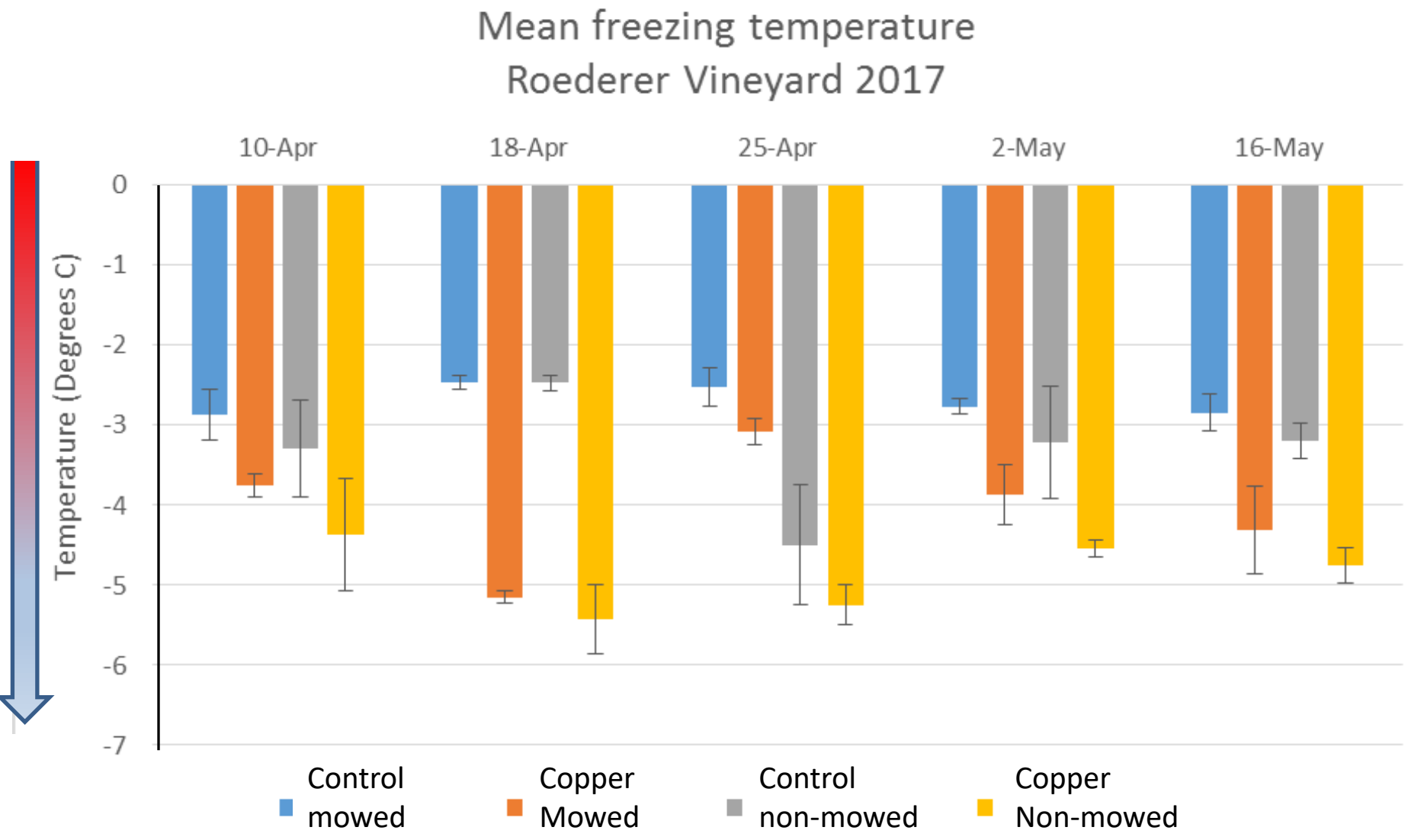
Air Deposition Plates



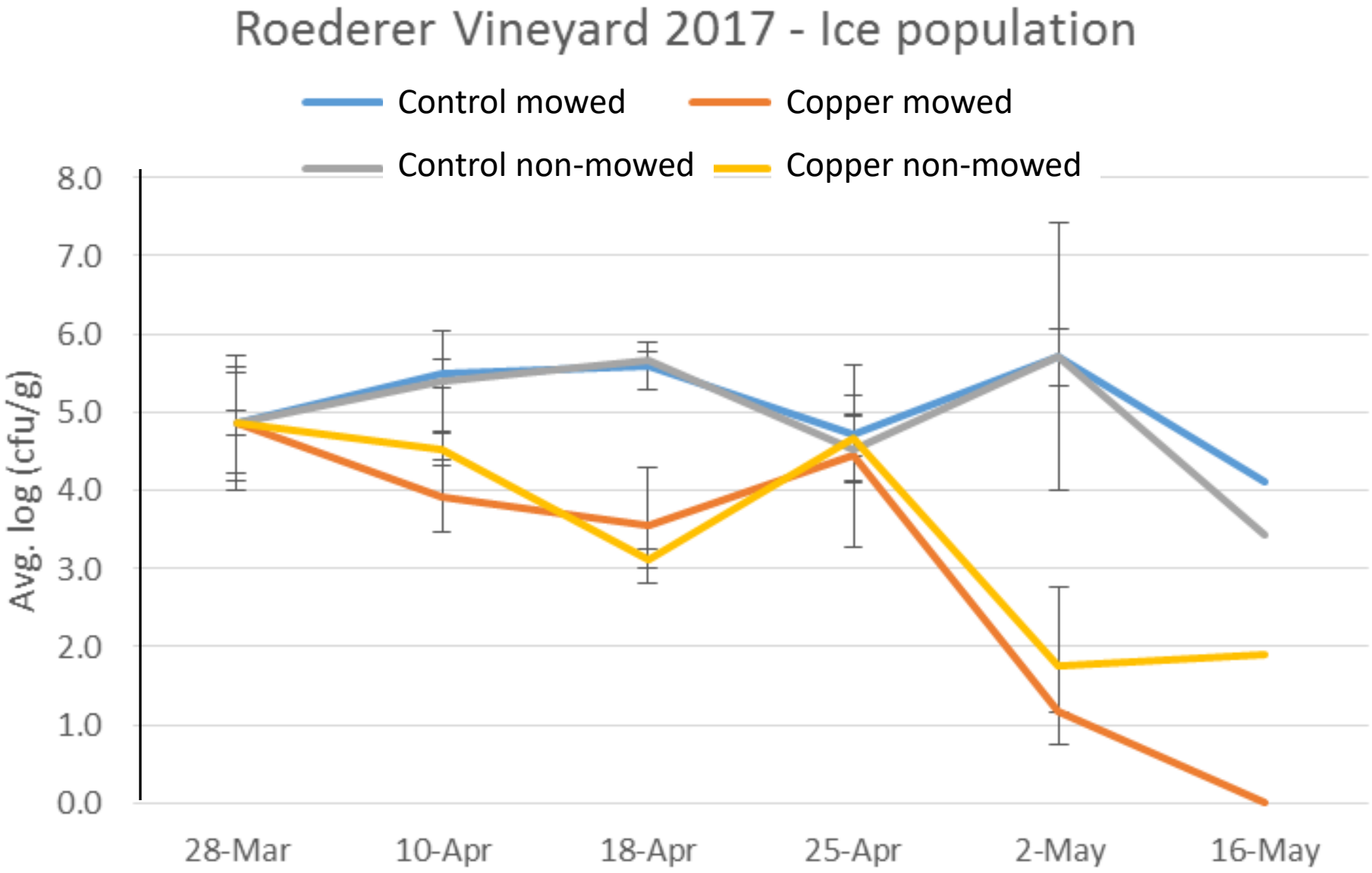
Copper greatly reduces bacterial numbers



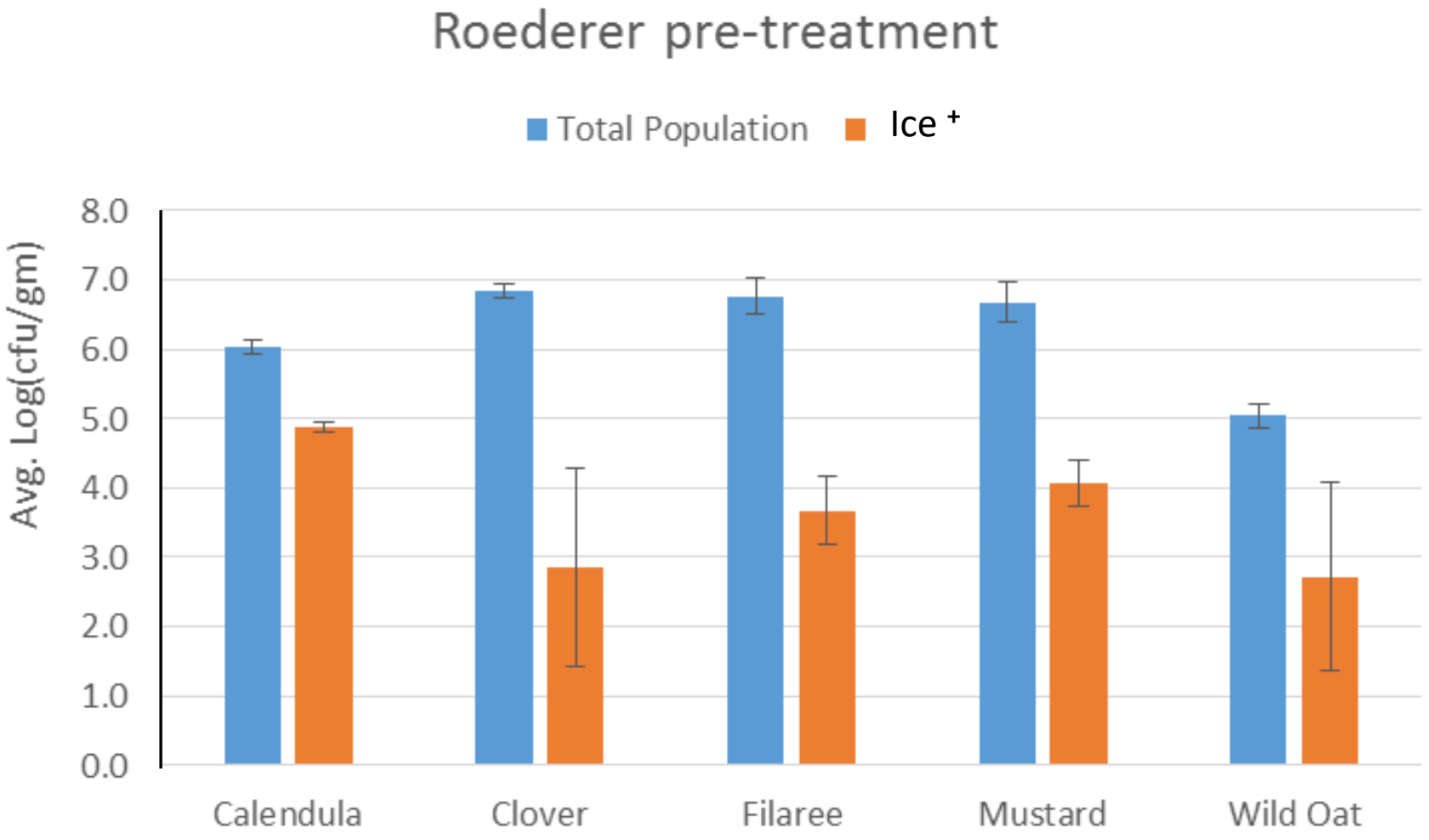
Copper reduces freezing temperature of shoots



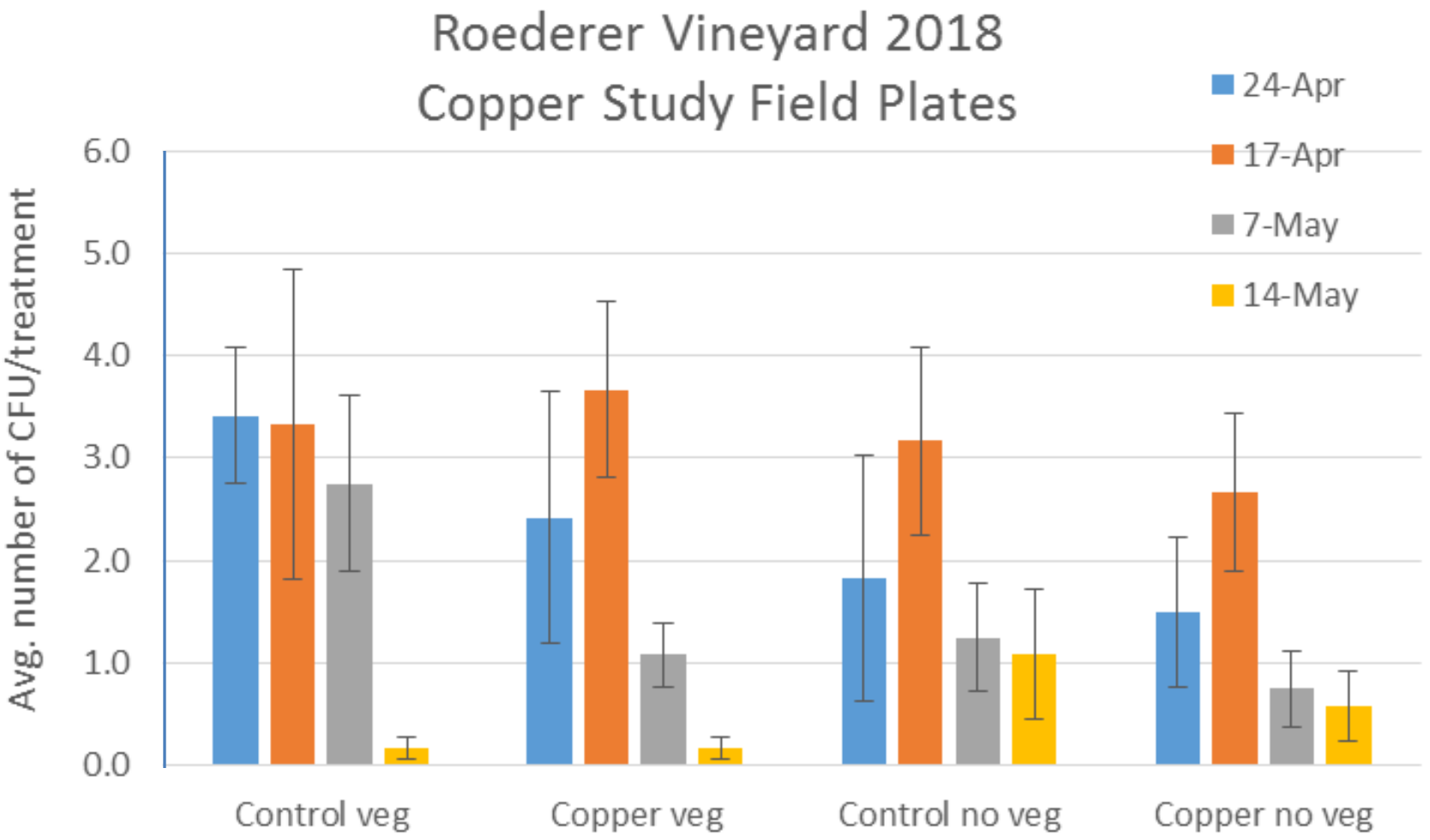
Copper reduces ice nucleation active bacteria on shoots



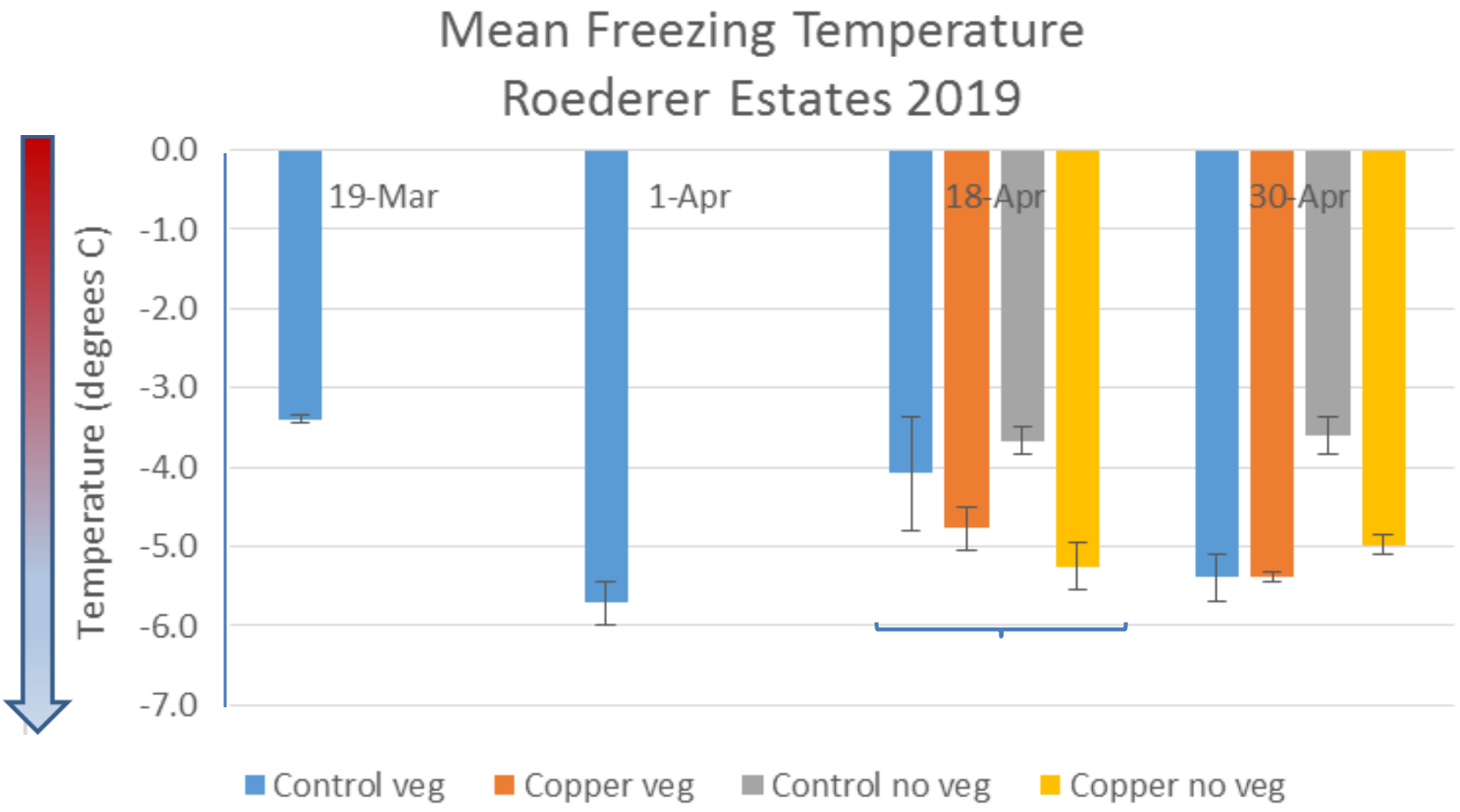
Roederer cover crop species harbor large numbers of bacteria in 2018



Higher bacterial numbers in air over vegetated areas of plot

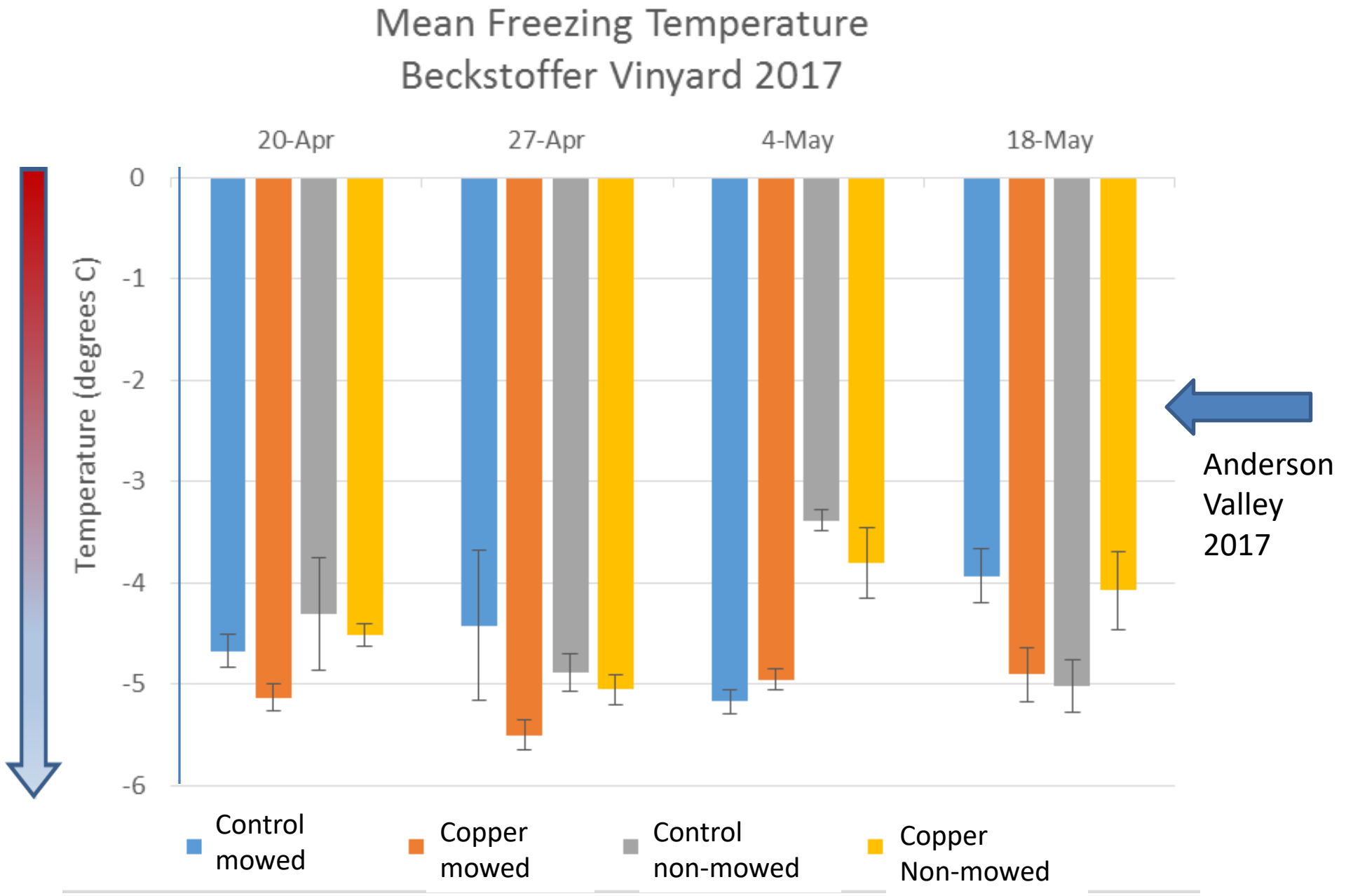


Copper applications had the dominant effect on reducing freezing temperature of shoots in 2019



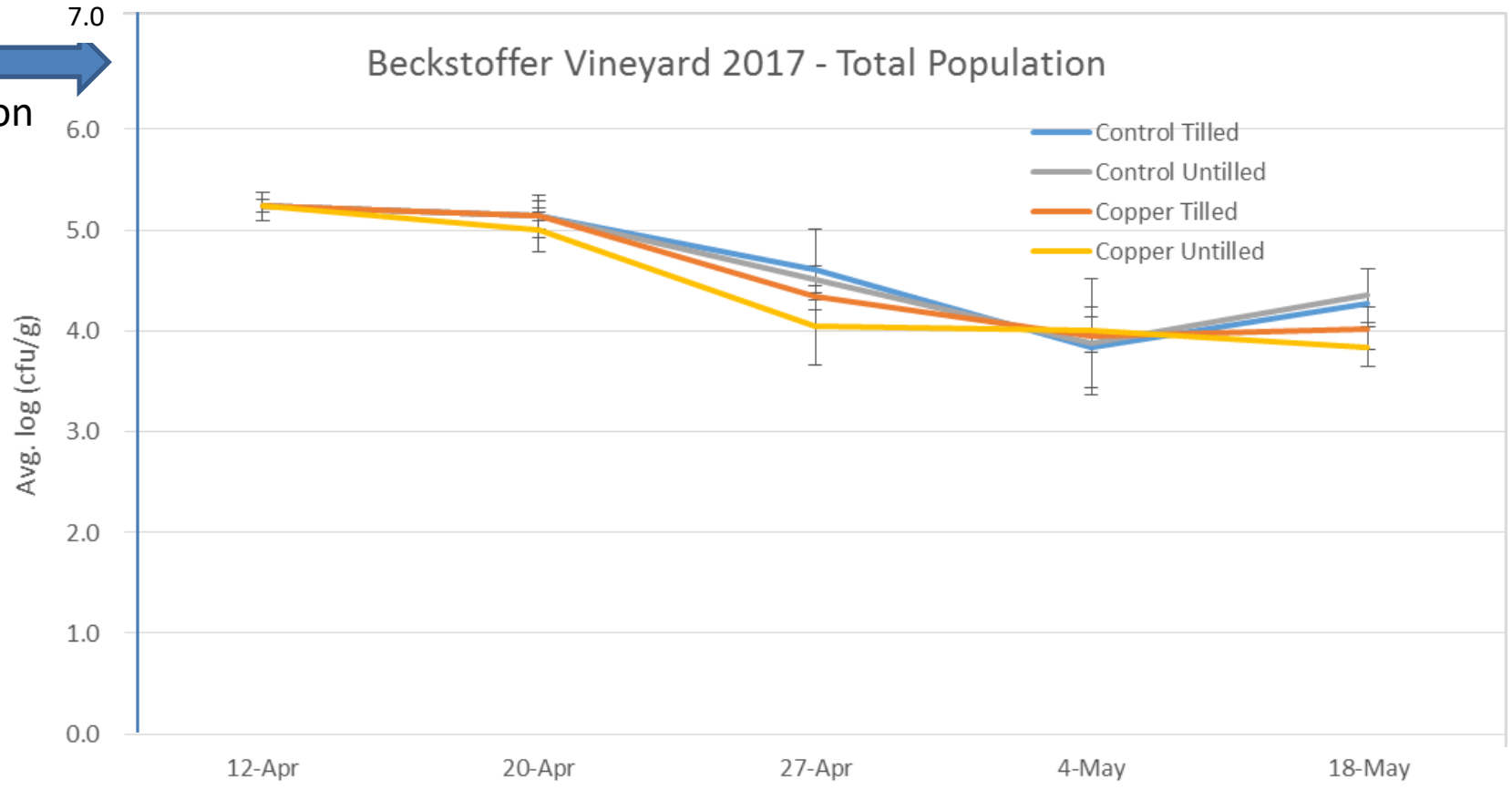
Lake County trials

Extensive supercooling of grape in Lake County compared to Anderson Valley
Modest effect of copper

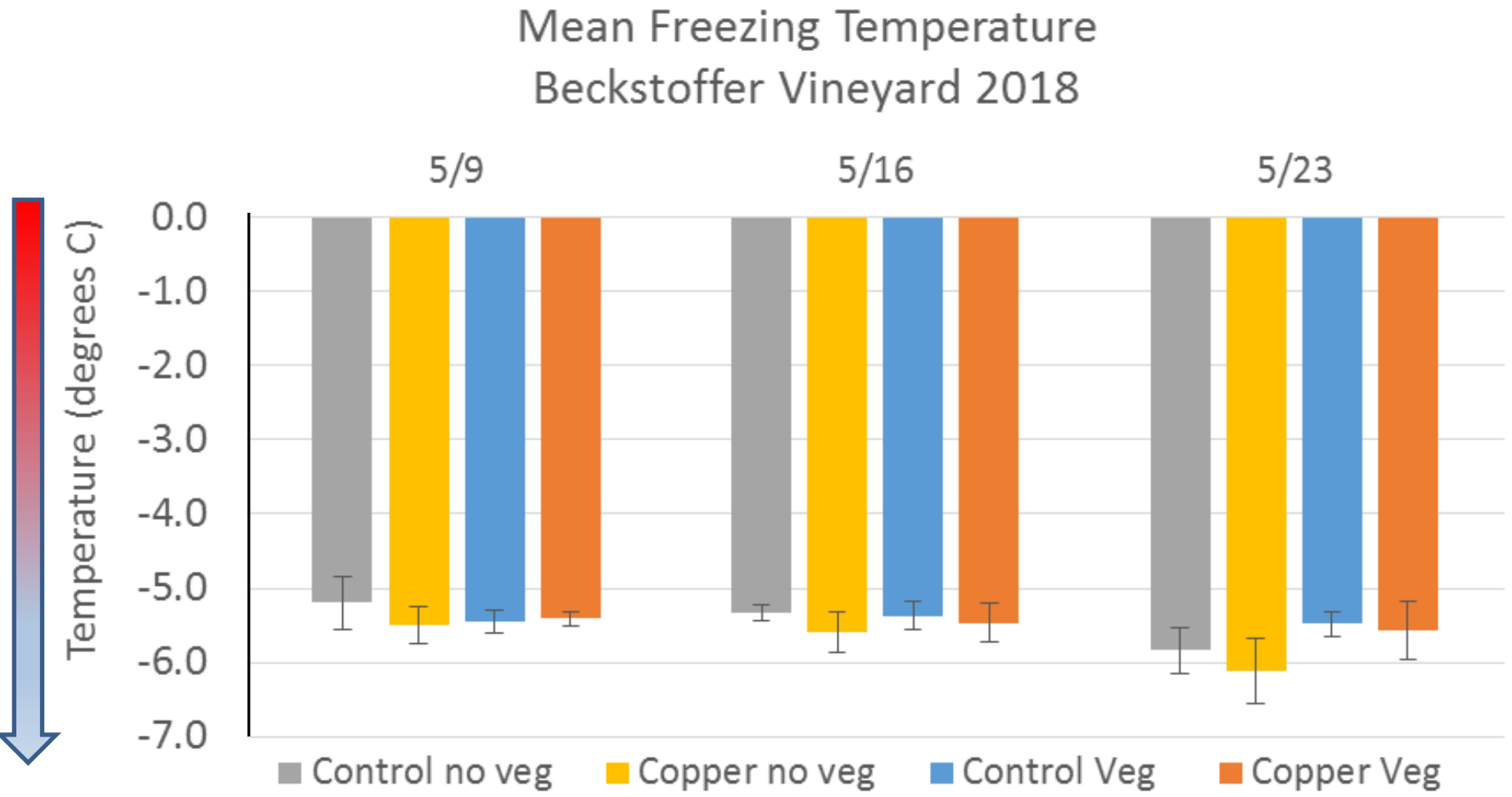


Much lower numbers of bacteria in Lake County than in Anderson Valley

Anderson Valley



Little effect of either copper or cover crop in 2018 - low freezing point of all treatments

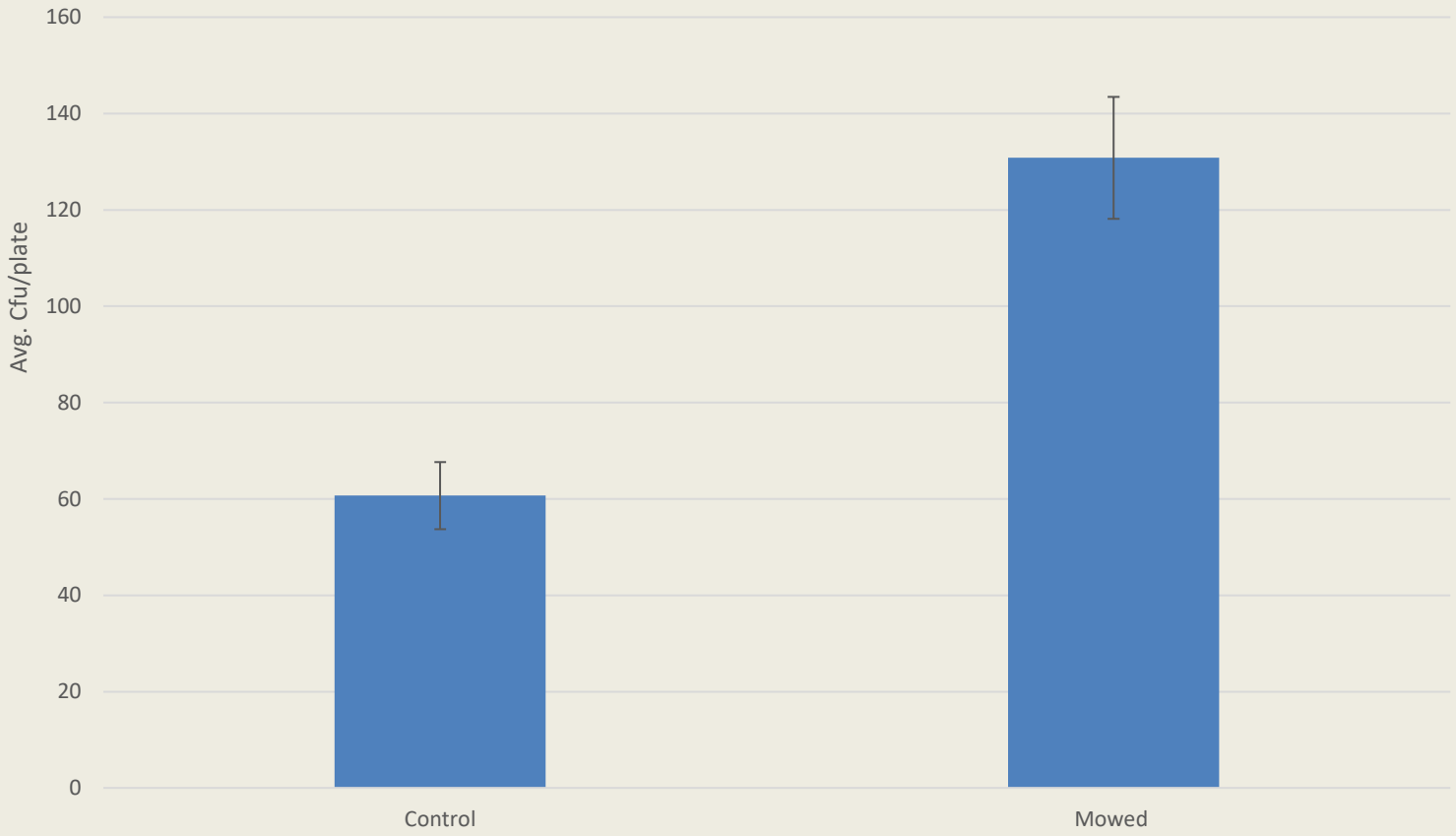


Summary

- Copper sprays reduce all bacteria and ice nucleating bacteria
- Reducing vineyard floor vegetation reduces all bacteria, and with copper sprays, effect is additive
- Lower bacteria numbers allow shoots to supercool in lab
- Could be a useful tool when no other frost control mitigation measures are available

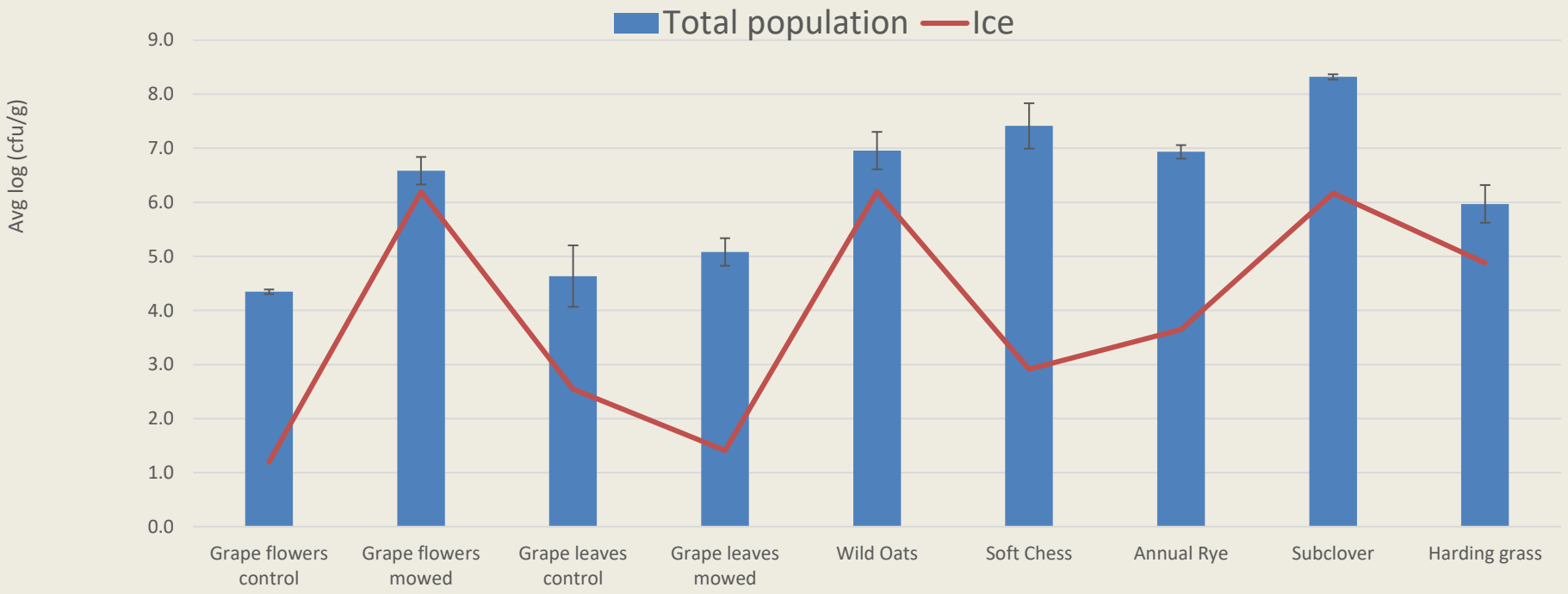
Does Mowing Spread Bacteria Around?

Bacteria Deposition During Mowing, May 15, 2017



‘Arneis’, Spirit Canyon Vineyard Hopland, California

Bacterial Populations, Plant Tissue
May 15, 2017



'Arneis', Spirit Canyon Vineyard Hopland, California

Thanks for Your Attention!