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Etiology and Management of Sour Rot in Grapes

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Abstract: Sour rot is a major challenge for affected grape growers and winemakers worldwide, yet basic disease etiology and management techniques are not well understood. Symptoms are characterized by fruit rot accompanied by the smell of acetic acid and presence of *Drosophila* (fruit fly) species. We've successfully reproduced these visual and olfactory disease symptoms and the accompanying characteristic production of ethanol and its conversion to acetic acid within affected berries, in the lab. Healthy fruit were wounded, inoculated with *Saccharomyces cerevisiae* and *Acetobacter aceti*, and exposed to *D. melanogaster* adults. Inoculation without exposure to flies significantly promoted ethanol production but not acetic acid generation, whereas concomitant exposure to flies resulted in both. In field trials conducted on cv. 'Vignoles' in 2013-15, both insecticide and antimicrobial treatments significantly reduced sour rot development. In 2015, untreated vines averaged 20.5% sour rot severity, and this was reduced by 73-81% on vines treated prophylactically post-veraison with weekly sprays containing a combination of the insecticide zeta-cypermethrin plus the antimicrobial potassium metabisulfite or hydrogen dioxide; severity was reduced by 49% on vines receiving only insecticide sprays. These trials further support the hypothesis that sour rot results from a complex of yeast, bacteria, and *Drosophila*, and that targeting these organisms can provide significant levels of control.

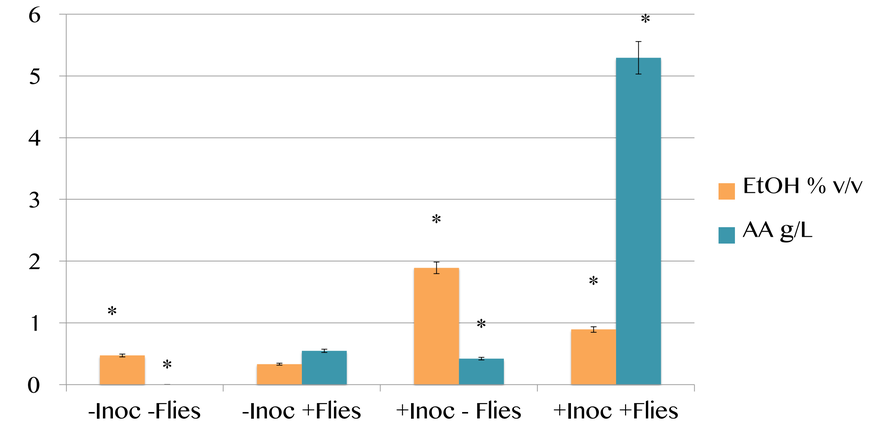
Introduction: Sour rot is a disease that affects grape growers worldwide. The grape skin and pulp becomes discolored, and most notably, smell strongly of acetic acid. *Drosophila* spp. (fruit flies) are commonly associated with the diseased berries in the vineyard. Since sour rot is a poorly-understood disease, we sought to define symptoms, determine the causal organisms, and to establish responsible strategies to better manage it.

Experiment #1: Microbial and insect inoculations; test of hypothesized etiology

Methods: 3 grape berries (*V. vinifera* cv. Red Globe) were surface sterilized in a 10% bleach solution, wounded with a sterile toothpick and either inoculated with distilled water or a suspension of *Saccharomyces cerevisiae* and *Acetobacter aceti*. The berries were placed in a sample cup containing a moistened piece of filter paper and 10 *D. melanogaster* adults were released into half of the sample cups, for a total of 4 treatments. After 5 days, the berries were macerated, the juice was filtered and then analyzed via HPLC to determine ethanol and acetic acid content.

Results: Of the four treatments, the only one yielding typical sour rot symptoms, including visual appearance plus the characteristic acetic acid smell, was the one that included inoculation of yeast + bacteria and the addition of *D. melanogaster* to the sample cup. Furthermore, HPLC analysis showed that berries that were inoculated but not exposed to flies had an average of 1.89% EtOH (v/v) and 0.42 g/L acetic acid, while inoculated berries exposed to flies had an average of 0.89% EtOH (v/v) and 5.3 g/L acetic acid, indicating that the addition of flies was correlated with the conversion of ethanol to acetic acid (Fig. 1).

Fig. 1. Ethanol and Acetic Acid Content of Inoculated Grapes



Experiment #2: Antimicrobial and Insecticide Sprays

Methods: A replicated split-plot management trial was established in a vineyard of the *Vitis* interspecific hybrid 'Vignoles' in Geneva, NY. Treatment (+ or -) with the insecticide Mustang Maxx (zeta-cypermethrin) to control *Drosophila* spp. was the split plot, with different antimicrobial treatments randomized within each replicate. The antimicrobial treatments were potassium metabisulfite (KMS), weekly starting either pre-symptoms or at symptoms; OxiDate 2.0 (hydrogen dioxide), weekly starting either pre-symptoms or at symptoms; and Fracture (BLAD polypeptide), weekly starting pre-symptoms or at symptoms, or once at 15° Brix; or untreated control.

Results: All three antimicrobial treatments applied to the vines prophylactically in combination with insecticide provided significant control of sour rot relative to the untreated vines, with an average 75% reduction in severity. Those vines that only received antimicrobial treatments at 15° Brix or at symptom development did not experience a significant reduction compared to vines not treated with antimicrobial sprays (Fig. 2).

Conclusions:

- **Sour rot symptoms were successfully recreated in the lab by wounding a healthy berry, inoculating that berry with a suspension of *S. cerevisiae* + *A. aceti*, and exposing the berries to vinegar flies, which led to the production of ethanol and its conversion to acetic acid.**
- **Antimicrobial + insecticide treatments applied before sour rot symptoms developed led to a 75% reduction in disease severity at harvest.**

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Fig. 2. Average % Sour Rot Severity by Treatment