

Dual Transcriptome Analysis Reveals Insights into Innate and Phosphite-Induced Resistance of Tanoak to *Phytophthora ramorum*¹

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Abstract

Phosphites have been used in the control of sudden oak death, however, the precise mode of action of these compounds is not fully understood. In order to study the action of phosphites in the context of naturally occurring host resistance, we designed an inoculation experiment on four open-pollinated tanoak families, previously defined as partially resistant. Stems of treatment-individuals were sprayed with phosphite, and 7 days later, distal leaves were inoculated with the sudden oak death pathogen, *Phytophthora ramorum*. Leaves from treated and untreated control plants were harvested for RNA extraction before and 7 days after inoculation, and transcriptomes of both host and pathogen were analyzed. We found that tanoak families differed in the presence of innate resistance and in the response to phosphite treatment. Sets of genes associated with innate resistance and with phosphite-induced resistance showed little overlap among tree families. However, sets of genes associated with innate resistance and with phosphite-induced resistance largely overlapped within a more susceptible but phosphite-treatment responsive tanoak family, supporting the hypothesis that phosphite treatment increases the resistance of susceptible host plants to *Phytophthora* infection. In addition, our dual RNA-Seq enabled us to monitor gene regulation of the pathogen *in planta*. Genes for energy generation such as those in the TCA cycle and genes for amino acid membrane transporters were upregulated, whereas elicitor genes were downregulated when comparing genic expression of *P. ramorum* in tanoak leaves relative to genic expression of *P. ramorum* mycelium in culture. We also found that genes of the pathogen involved in detoxification, such as ATP-binding cassette (ABC) transporters and vitamin B₆ biosynthesis genes, were upregulated in phosphite-treated plants, but not in untreated plants. Upregulation of these genes has been observed for axenic culture of *P. cinnamomi* in the presence of phosphite, indicating these genes responded to the direct toxicity of phosphite. In summary, our dual RNA-Seq supports a dual mode of action of phosphite compounds, including a direct toxic effect on *P. ramorum* and an indirect enhancement of resistance in the tanoak host.

¹ A version of the paper was presented at the Seventh Sudden Oak Death Science and Management Symposium, June 25-27, 2019, San Francisco, California.

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