Transcriptome Analysis of Tanoak Reveals Divergent Mechanisms of Innate and Phosphite-Induced Resistance to *Phytophthora ramorum*[1]

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Abstract

Phosphite compounds have been used in the control of sudden oak death; however, their precise mode of action is not fully understood. To study the action of phosphite compounds in the context of naturally occurring host resistance, we first identified open-pollinated family groups that carried resistance, that is in which approximately 20% of offspring demonstrated a quantitatively resistant phenotype, with zero or little dieback post-inoculation. Then, multiple inoculations were performed on previously unchallenged members of these families, half of which had been treated with phosphite. Leaves were harvested and flash-frozen before and at 1 week after inoculation for RNA extraction. The remaining inoculated leaves were left intact, and the trees were followed over the course of 6 weeks to determine disease phenotype. The transcriptomes of saplings from two families were sequenced. Quantitative PCR for 80 targets in the same saplings was used for technical validation of the quantitative sequencing results, and in saplings from the two additional families for biological validation. The design and the phenotypic results allowed us to study gene expression during the disease response in phosphite-treated, resistant hosts (in which the treatment worked as expected); in phosphite-treated but susceptible hosts (in which phosphite was not effective nor was there innate resistance); and in untreated susceptible and resistant trees. As expected, we found that tanoak families differed in the presence of innate resistance and in the effectiveness of phosphite treatment. There were 9,705 genes that were differentially expressed between untreated resistant trees and untreated susceptible trees. In comparison, there were seven genes differentially expressed in the same comparison between susceptible and resistant phosphite-treated trees. Constitutive expression of some disease-related genes was linked with innate resistance: several genes were identified which had much increased expression in untreated, resistant trees prior to inoculation, but were more strongly expressed in untreated susceptible and phosphite treated trees after inoculation. These included genes associated with signaling and production of secondary compounds. Our results demonstrate the differences in mode of action of phosphite compounds from innate resistance, and an intriguing lack of difference in gene expression between phosphite-treated trees, whether diseased or apparently healthy.

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