HETEROPLASMY FOR THE CYTOCHROME *B* GENE IN *Podosphaera xanthii* AND ITS ROLE IN RESISTANCE TO QOI FUNGICIDES IN SPAIN

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Powdery mildew elicited by *Podosphaera xanthii* is a devastating disease of cucurbits worldwide and one of the most important diseases affecting these crops in Spain. Application of fungicides is the main control practice in most cucurbit crops for managing powdery mildew. The quinone outside inhibitors (QoI) represent an important class of agricultural fungicides, which are widely used in Spain against the powdery mildew disease. QoI have a single-site mode of action inhibiting mitochondrial respiration by binding to the Qo site of the cytochrome bc_1 enzyme complex, thus blocking electron transfer in the respiration pathway and leading to and energy deficiency due a lack of ATP. In a previous report, widespread resistance to QoI fungicides in populations of *P. xanthii* in South central Spain was documented, but the molecular mechanisms of resistance remained unclear. In this work, the role of cytochrome *b* (*cytb*) gene mutations in QoI resistance of *P. xanthii* was examined. Sequence analysis of a cloned fragment of *cytb* revealed the presence of a G143A substitution that occurs in many QoI-resistant fungi. This mutation was always detected in QoI-resistant isolates of *P. xanthii*; however, it was also detected in sensitive isolates. To better understand the role of heteroplasmy for *cytb* in QoI resistance of *P. xanthii*, an allele-specific quantitative polymerase chain reaction was developed to quantify the relative abundance of the A143 (resistant) allele. Our data suggest that G143A mutation in *cytb* is the primary factor involved in QoI resistance of *P. xanthii;* however, the proportion of G143 and A143 alleles in an isolate may determine its QoI resistance level. In addition, the role of the Rieske-FeS protein (ISP), the other protein component of the Qo site, in QoI resistance was also examined.

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