CITRUS ADVANCED TECHNOLOGY PROGRAM

QUARTERLY & FINAL REPORTS: Control of Citrus Greening, Canker & Emerging Diseases of Citrus

SELECT PERIOD December 2012

○ *Quarterly Report* ● *Final*

Proposal Title

Transferring disease resistance technology from a model system to citrus

Today's Date	Sponsoring Organization (drop-down)	Category (drop down)
1/8/13	Citrus Research and Development Foundation	Transgenic/Metagenomic Mediation of Resistance

REPORT UPDATE (500 words-It is not necessary in this public report to disclose your institution's proprietary information or intellectual property.)

The overall goal of this project was to transfer disease resistance technology from Arabidopsis to citrus. Two specific aims were proposed in the original proposal. One was to overexpress the Arabidopsis MAP kinase kinase 7 (MKK7) gene in citrus to increase disease resistance (Transgenic approach), and the other was to select for citrus mutants with increased disease resistance (Non-transgenic approach).

For specific aim #1, we have generated not only transgenic citrus plants overexpressing MKK7 but also transgenic plants overexpressing several other Arabidopsis disease resistance genes including NPR1, NAC1, MOD1, and EDS5. While disease resistance test for most of the transgenic plants is underway, transgenic plants overexpressing NPR1 were found to have increased resistance to citrus canker (see below). For specific aim #2, we have tested different citrus plant materials for mutagenesis, including calli, hypocotyls, and seeds. Chemical genetic screens have been carried out using these materials. In the last year of the project, we started a direct genetic screen for citrus greening-resistant varieties using grapefruit seeds mutated with gamma ray irradiation. This screen is still ongoing.

During the project, we not only tried to accomplish the originally proposed work, but also explored the recently discovered disease resistance technology in the model plant Arabidopsis. At the end of the project, several significant results have been obtained.

(1) We found that overexpression of the Arabidopsis NPR1 gene, which is a key regulator of systemic acquired resistance (SAR), in citrus increases resistance to citrus canker. This result has been published in European Journal of Plant Pathology. Furthermore, we found that the transgenic plants overexpressing NPR1 did not have increased resistance to citrus greening.
(2) We found that the citrus canker-causing bacterial pathogen Xanthomonas citri subsp. citri (Xcc) is a nonhost pathogen of the model plant Arabidopsis. We discovered that Xcc neither grows nor declines in Arabidopsis, but induces strong defense gene expression. This result has been published in PLoS ONE.
(3) Using the Arabidopsis-Xcc pathosystem, we found that the salicylic acid (SA) signaling pathway contributes to nonhost resistance against Xcc in Arabidopsis. Several genes of the SA signaling pathway were found to contribute to nonhost resistance against Xcc.
(4) We found a group of novel genes, which play critical roles in nonhost resistance against Xcc in Arabidopsis. We revealed that Xcc grows significantly more in mutants of these genes. For instance, in one of these mutants, Xcc grows about 50-fold more than in the wild type, suggesting that the corresponding gene is a critical regulator of nonhost resistance against Xcc. More importantly, we found that overexpression of this gene confers resistance to several virulent bacterial pathogens; therefore, the newly discovered nonhost resistance genes hold great potential for generating disease-resistant citrus varieties.
(5) We found that exogenous NAD+, which induces strong SAR in Arabidopsis, activates strong resistance to citrus canker, suggesting that the NAD+-mediated defense signaling pathway is highly effective against citrus diseases. Therefore, components we have identified in the NAD+-mediated signaling pathway could be used to engineer resistance to citrus greening and/or canker.

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