Partial Resistance of Carrot to Alternaria dauci Correlates with In Vitro Cultured Carrot Cell Resistance to Fungal Exudates

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Although different mechanisms have been proposed in the recent years, plant pathogen partial resistance is still poorly understood. Components of the chemical warfare, including the production of plant defense compounds and plant resistance to pathogen-produced toxins, are likely to play a role. Toxins are indeed recognized as important determinants of pathogenicity in necrotrophic fungi. Partial resistance based on quantitative resistance loci and linked to a pathogen-produced toxin has never been fully described. We tested this hypothesis using the Alternaria dauci – carrot pathosystem. Alternaria dauci, causing carrot leaf blight, is a necrotrophic fungus known to produce zinniol, a compound described as a non-host selective toxin. Embryogenic cellular cultures from carrot genotypes varying in resistance against A. dauci were confronted with zinniol at different concentrations or to fungal exudates (raw, organic or aqueous extracts). The plant response was analyzed through the measurement of cytoplasmic esterase activity, as a marker of cell viability, and the differentiation of somatic embryos in cellular cultures. A differential response to toxicity was demonstrated between susceptible and partially resistant genotypes, with a good correlation noted between the resistance to the fungus at the whole plant level and resistance at the cellular level to fungal exudates from raw and organic extracts. No toxic reaction of embryogenic cultures was observed after treatment with the aqueous extract or zinniol used at physiological concentration. Moreover, we did not detect zinniol in toxic fungal extracts by UHPLC analysis. These results suggest that strong phytotoxic compounds are present in the organic extract and remain to be characterized. Our results clearly show that carrot tolerance to A. dauci toxins is one component of its partial resistance.