The Engineering of Plant Disease Resistance

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Extensive analyses of plant responses to pathogen infection in laboratories world-wide have shown that plants contain highly complex resistance pathways involving hundreds of different proteins. Based on a partial understanding of these responses, several strategies are currently being employed by Monsanto to engineer broad-spectrum disease control in transgenic plants. One strategy is centered around single resistance (R) genes. Activated R genes trigger signaling pathways leading to both a localized hypersensitivity (HR) and a systemic induction of pathogenesis-related (PR) proteins. Since R gene products contain conserved domains, they can be cloned by homology for transfer to crops of interest. Another strategy is based on the finding that different classes of downstream pathogen-inducible genes display *in vitro* anti-microbial activity. Members of these classes encode, apart from PR proteins, defensins, thionins, lipid transfer proteins, and proteinase inhibitors. Monsanto scientists are creating transgenic plants that are resistant to various fungal diseases by transferring antifungal protein (AFPs) genes into the plant genome. In potato, AFPs confer resistance to early dying of potato in field trials. The recent isolation of genes encoding putative transcription factors in disease control allowed development of a third strategy to engineer resistance. This strategy is aimed at enhancing levels of disease control by overexpressing genes such as the *Arabidopsis* Npr1 gene. Many additional signaling proteins may play key roles in resistance and should be tested for their efficacy. To include "all" plant proteins in searches for novel resistance determinants, strategies are developed that utilize genomics based technologies such as microarraying and high-throughput EST sequencing.

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