Harnessing Plant Defense Elicitors for Sustainable Crop Protection

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Plant defense elicitors are exogenous molecules that activate a plant's immune system without directly harming pathogens. By mimicking chemical signatures of attack or damage (PAMPs/DAMPs), elicitors prime plants to mount faster and stronger defensive responses upon infection. This strategy offers a sustainable complement to conventional fungicides, addressing challenges linked to pesticide overuse, resistance development, and environmental impact. Elicitors also provide management options for difficult-to-control diseases—such as bacterial infections—where chemical control is limited. We evaluated multiple elicitors to study the translation of greenhouse to (semi-) field resistance inducing in tomato (Solanum lycopersicum) to early blight caused by Alternaria solani. In field trials, plants were treated with various commercial and naturally-occurring elicitors at regular application intervals prior to pathogen inoculation. Disease progression was monitored, and plant immune activation was assessed via qPCR analysis of key defense-related genes associated with salicylic acid (SA) and jasmonic acid (JA) signaling pathways. Several elicitors significantly reduced early blight severity compared to untreated controls. A chitosan-based elicitor notably lowered disease incidence. However, naturally-occurring elicitors that showed efficacy in greenhouse trials failed to replicate these results under field conditions. Plants treated with effective elicitors showed elevated expression of defense genes (PR1, PR2, PAL, CAT etc.), consistent with induced resistance. Our findings demonstrate that plant defense elicitors can enhance tomato resilience and reduce disease pressure under field conditions. However, as preventive rather than curative agents, elicitors should be integrated within holistic disease management programs alongside—not as replacements for—conventional fungicides. This work highlights both the promise of elicitor-based strategies and the persistent gap between controlled-environment and field performance, underscoring the need for continued research to optimize elicitor applications for sustainable crop protection