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Biocontrol Efficacy of Endophytes in Mitigating *Phytophthora capsici* Disease Progression: A Greenhouse Trial Approach

ABSTRACT

Phytophthora capsici is a highly aggressive and destructive pathogen causing root and crown rot, as well fruits and foliage blight in a wide range of crops. Traditionally, this disease is controlled using fungicides, but development of fungicide resistance and environmental concerns over fungicide toxicities to soil, water, humans and other organisms, necessitate the need for alternative products that are safer and ecofriendly. Selected endophytes that colonize plants internally without causing harm to the host plants have shown efficacy on diverse fungal pathogens in dual cultures. Four bacterial endophytes that displayed efficacy in suppressing *P. capsici* growth were evaluated for mitigating *P. capsici* disease progression in pepper (*Capsicum annum*) in greenhouse studies. The bacterial endophytes were introduced to plants by priming the seed before inoculating the plants with *P. capsici.* Four individual endophytes were evaluated in replicated experiments and compared to Bonide copper fungicide) and water control. Evaluation of disease development displayed significant variations in disease severity in different endophyte treatments starting day 15 during which endophyte EN13A exhibited strong disease suppression, with minimal disease symptoms and a severity score of 0.4, while treatment with EN2B displayed relatively low severity of 1.0, EN39A showed a severity of 1.8, and EN30C displayed moderate disease severity of 2.4. compared to the nontreated water control that showed greater disease progression with a severity of 2.8, and the fungicide-treated plants exhibiting a disease score of 2.6. in a scale of 0-5 where 0=no disease and 5 is plant death. As disease progression intensified over time, particularly in the untreated and fungicide-treated plants, treatments with EN13A continued to show robust resistance, maintaining a low severity of 0.6. EN2B progressed slightly to 1.2, EN39A increased to 2.6 while EN30C's severity increased to 3.0. The control group severity rose sharply to 4.2, and the fungicide-treated plants showed a moderate increase to 3.2. On Day 25, EN13A maintained its low disease severity (0.8) and continued to demonstrate strong suppression of *P. capsici* while EN2B exhibited a slight increase to 1.6, EN39A's severity increased to 3.4, a EN30C's severity rose to 4.0 and water control group reached a severity of 4.8, closely followed by fungicide-treated plants at 4.6. By Day 30, EN13A remained highly effective in disease suppression, with a severity score of 1.0. while EN2B showed a moderate severity of 1.8. and EN30C and EN39A reached peak severities of 4.8 and 4.0, respectively and water control and fungicide-treated plants reached maximum severity (5.0) with dead plants. These results showed that the biocontrol potential of endophytes EN13A and EN2B was high. However, their agricultural viability and potential for integration into crop protection strategies require field studies. In addition, biochemical and molecular profiling of the selected endophytes is needed to determine disease control mechanisms.

Keywords: *Phytophthora capsici*, biocontrol, endophytes, sustainable agriculture, greenhouse trials, integrated pest management, plant pathogens.