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Mini Review

Exploring Beneficial Plant Root Microbiomes as a Novel Tool for Sustainable Crop Disease Control in Canadian Greenhouses

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Abstract

Canadian greenhouses cover 23 million square metres of production area which supplies both domestic and export markets, and are a significant contributor to the Canadian economy. The farm gate value of greenhouse vegetables was approximately 1.3 billion dollars in 2015. The fungal and fungal-like root diseases of plants can have serious economic constraints to greenhouse production industry. The fungal and fungal-like species that causes root diseases mainly includes *Pythium, Phytophthora, Rhizoctonia* and *Fusarium*. The excessive use of agrochemicals to control these pathogens is not only harmful to environment and human health but also develops more resistant varieties of pathogens. Hence, it is essential to develop novel green technologies for greenhouse sector to suppress these pathogens. The beneficial microbial communities of roots that are capable of suppressing these pathogens should be explored for sustainable protection of greenhouse crops.

Keywords: *Canadian Greenhouses; Root Microbiomes; Pythium; Phytophthora*

Introduction

Canadian greenhouse sector occupies over 124 hectares with Ontario being largest producer of greenhouse vegetables followed by British Columbia and Quebec according to Statistics Canada in 2015. Some of the important cash vegetable crops are tomato, pepper, cucumber and lettuce. Root diseases in vegetables have severe impact on seeds survival, crop growth, yield and quality and ultimately, sustainable vegetable production. Soilless cultures were developed to control soil borne pathogens such as, fungi, nematodes, and bacteria. However, the major problem for greenhouse hydroponic vegetable production is diseases caused by zoosporic fungi that are well adapted to aquatic environments. Root colonisation by zoosporic fungal-like microorganisms such as, *Pythium* and *Phytophthora* spp. in hydroponics can be symptomless [1,2]. These microorganisms contaminate irrigation water and hence, are threats to the growth and production of greenhouse crops in soilless cultures. For example, damping off caused by *Pythium, Phytophthora*, and *Rhizoctoniasolani* in a variety of vegetable crops, reduces seedlings emerging and falling over of young seedlings [3]. Another example is of *Fusarium* crown and root rot which is a serious fungal disease that severely affects young seedling. Infected plants show marked thinness at the top of the stem and plants begin to wilt [3]. These diseases impact growth, quality and marketable yield of vegetable crops. The incidence and severity varies and is related to multiple abiotic and biotic factors in soil and soilless cultures.

Greenhouse producers are using fumigation and biofumigation as an effective and economical method for controlling plant diseases. Proper sanitation, various disinfection methods, cultural practices and various biological control products are used to control plant pathogens (http://www.omafra.gov.on.ca/english/crops/pub835/p835order.htm, biopesticide database directory at https://www5.agr.gc.ca/MPDD-CPM/search-recherche.do?lang=eng. However, one of the disadvantages of disinfection methods is that they eliminate beneficial microflora of plants. Natural microflora may contain antagonistic microorganisms that can suppress many plant pathogens in greenhouses [4].

Use of biocontrol agents based on single microorganisms often lacks consistent antagonistic activity in greenhouses. In particular, they are unable to colonise plant roots for longer periods [5]. This is because *in vitro* selection of biocontrol agent often lacks study on co-dependent antagonistic activities of a root microbiome. Hence, a possible solution for effective disease management may be achieved by increasing population of beneficial microbial communities in commercial greenhouse crop systems. This aspect has not been investigated in depth under soil and soilless cultures.

Future Perspective

Exploring benefits of healthy root microbiome is exciting and opens new avenues of green agriculture by reducing chemical inputs and improving crop quality for pest-free and sustainable high-quality crop production. However, the bigger challenge is to develop technologies and optimize protocols for beneficial microbiomes, long shelf lives, effectiveness against pathogens and persistence under harsh environment. Probing this in particular using hydroponics systems, can lay foundation for developing similar microbiome approach in complex soil ecosystems for integrated pest management of economically important agricultural crops of Canada.

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