Managing Verticillium Stripe in Canola Through Genetics, Omics, and Understanding the *Brassica napus - Verticillium longisporum* Interaction

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INTRODUCTION

- Canola (*Brassica napus* L.) is the number one oilseed and cash crop in Canada.
- Utilization of canola spread to a broad range including vegetable oil, food products, livestock production, and non-edible uses.
- Canola has become one of the most valuable agricultural exports and an important source of income for 43,000 Canadian farmers and more than 207,000 Canadian jobs are linked to canola. Therefore, it has become a powerful engine for economic growth in Canada.
- *Verticillium longisporum* (VL) is a soil-borne fungal pathogen that can infect *Brassica* family plants such as broccoli, cauliflower, cabbage, and canola.
- *V. longisporum* has three lineages: A1D1, A1D2, and A1D3. A1D1 is considered as the most virulent lineage while A1D2 is the least. *V. longisporum* A1D1 is predominant across canola growing areas in Canada.
- *V. longisporum* can cause an important vascular disease called **Verticillium stripe disease** in canola (**Figure 1**).
- Infection occurs in roots by penetrating the hyphae of the pathogen.
- Colonization of the above ground parts occurs through hyphal growth and the production of conidia in vascular system.
- The first incidence of the disease in Canada was in Manitoba in 2014 (Zou *et al*. 2020). Currently, it has spread to Alberta, Saskatchewan, Ontario, and Quebec.

OBJECTIVES

1. Assessment of the pathogenicity variations of *V. longisporum* A1D1 lineage.

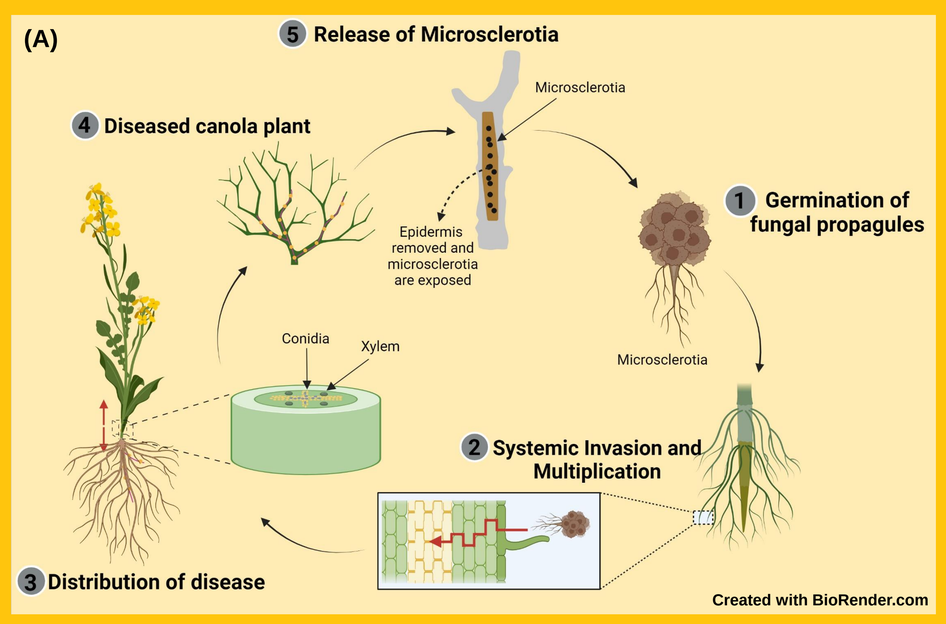
2. Disease progression evaluation in
- Root
- Hypocotyl
- Cotyledon
- Leaves

Study the impact of *V. longisporum* on the

3. Expression of genes involved in **Plant signaling transduction**
- Auxin
- Gibberellin
- Abscisic acid
- Cytokinin
- Ethylene

4. The activity of **Antioxidant enzymes**
- Superoxide dismutase (SOD)
- Catalase (CAT)
- Peroxidase (POX)
- Glutathione Peroxidase (GPX)
- Glutathione reductase (GR)
- Glutathione S-transferases (GST)
- Ascorbate peroxidase (APX)

DISEASE BACKGROUND

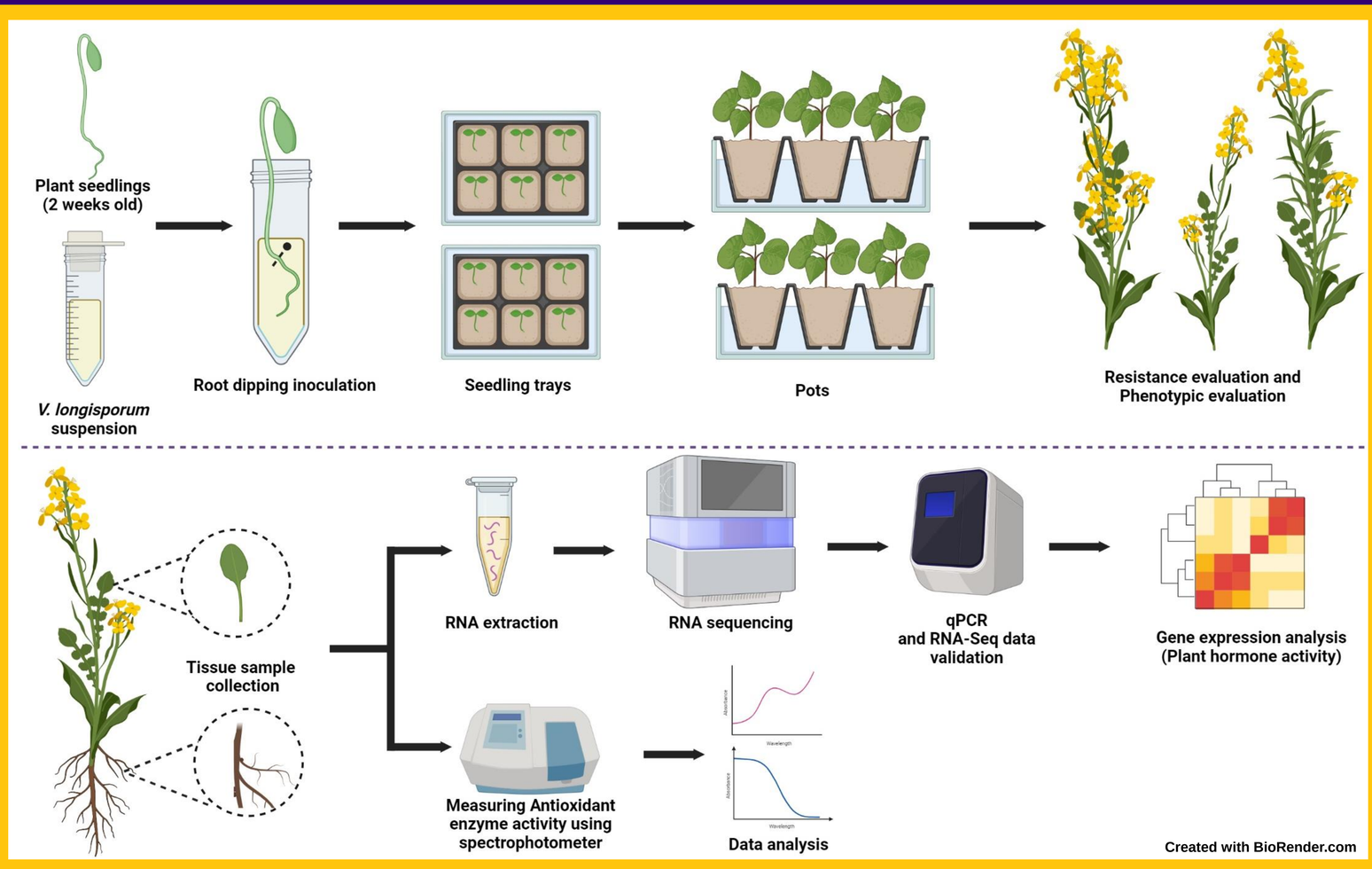


Source: https://www.manitobacooperator.ca

Source: https://www.producer.com

Figure 1: (A) Disease cycle of *Verticillium longisporum*. **(B)** and **(C)** depict the disease symptoms of Verticillium stripe on canola plants. The disease symptoms include leaf chlorosis, early ripening, stunting, and, as the disease progresses, necrosis and shredding of the stem tissue. These symptoms are primarily noticeable on the stems and roots. In mature plants, tiny black microsclerotia can be observed on the stem peels.

MATERIALS AND METHODS



- VL isolate A1D1 will be used to prepare the conidial suspension and then for inoculation. Surface sterilized seeds will be kept in moistened filter paper in Petri dishes for 7 days to allow germination. The roots of 1-week-old seedlings will be wounded and dipped in the conidial suspensions (1×10^7 spores mL^{-1}) for 45 min prior to transferring them to the seedling trays (Zheng *et al.* 2019).
- Disease severity at 7dpi (days post-inoculation) will be assessed from 0 to 6 scale (0 = no symptoms; 1 = yellowing of cotyledons; 2 = yellowing and partial necrosis of cotyledons, some reduced growth of first true leaves; 3 = death of cotyledons, seedling stunted; 4 = death of cotyledons, seedling stunted, true leaves yellow; 5 = death of cotyledons, seedling stunted, little to no growth of true leaves; and 6 = seedling entirely necrotic) (Cui *et al.* 2023).
- The differences of the gene responsible for plant hormonal activity will be identified using RNA-Seq technique and the variation of the antioxidant enzyme activity will be assessed.

EXPECTED OUTCOMES

- Enhancing our understanding of the development of Verticillium stripe disease in canola.
- Investigating the disease progression in roots, hypocotyl, cotyledon, and leaves.
- Comparing the differentially expressed genes in *V. longsiporum - B. napus* interaction at 7 dpi and 14 dpi.
- Assessing the variation in gene expression related to plant growth-regulating hormones in response to the disease.
- Providing a detailed explanation of the behavioral differences in plant antioxidant enzymes against *V. longsiporum* infection using DAB staining (for hydrogen peroxide activity) and the Nitroblue tetrazolium test/NBT (for reactive oxygen species).

REFERENCES

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