Verticillium Stripe (*Verticillium longisporum*) in Manitoba: A Field-Focused Review

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Overview of Verticillium Stripe (*Verticillium longisporum*)

Verticillium longisporum is a soil-borne fungal pathogen that particularly infects the Brassica family including canola to cause the disease Verticillium Stripe (VS). There are three amphidiploid lineages hybridized from four different parents (A1/D1, A1/D2, and A1/D3), with the A1/D1 genotype being the most virulent on *Brassica napus* (Tiedemann et al. 2022). The origin of the A1 and D1 parental lineages that hybridized are unknown at this time (Feng et al. 2024). *V. longisporum* has been identified to date in Europe, Russia, Japan, China, Canada, and the United States (Feng et al. 2024; Chapara et al. 2023). In Canada, *V. longisporum* was first identified in Manitoba in 2014. The fungal pathogen begins as melanized microsclerotia (mass of spores) dormant in the soil, where they germinate and penetrate into the root cortex (Tiedemann et al. 2019; Hwang et al. 2022). The hyphae are restricted to the root zone until the plant's later maturity, where they produce conidia sent through the xylem and occupy mature stem parenchyma to form microsclerotia beneath the stem epidermis (Tiedemann et al. 2019; Hwang et al. 2022; Zhang et al. 2025). The infected, mature plant's stem will shred naturally and during plant breakdown, releasing further *V. longisporum* microsclerotia into the soil and beginning the cycle (Figure 1) again (Hwang et al. 2022). The microsclerotia are estimated to be able to remain on residue for the preceding year but also remain dormant in the soil for >10 years, although this needs to be studied under Canadian conditions (Tiedemann et al. 2019; Strelkov et al. 2025). The majority of European research has focused on winter oilseed rape (*Brassica napus*), but research suggests that due to warmer spring temperatures with spring-planted canola there is faster growth of *V. longisporum*, increasing the potential damage of this fungal pathogen to spring canola (Cornelsen et al. 2023). Disease development of verticillium stripe is hypothesized to be encouraged by hot, dry weather conditions, although this is not always seen in literature (Soesanto et al. 2001). Though as a close relative of *Verticillium dahliae*, *V. longisporum* may have significantly longer conidia, irregular microsclerotia, and more branched hyphae than *V. dahliae* (Figure 2).

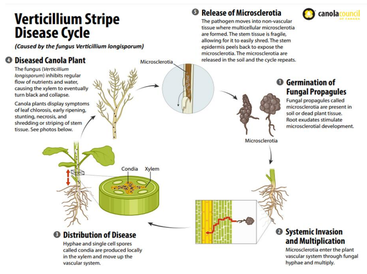


Figure 1. Verticillium stripe (*Verticillium longisporum*) disease cycle (Source: Canola Council of Canada)

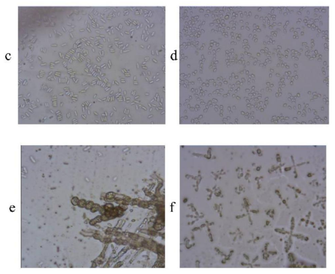


Figure 2. *Verticillium longisporum* conidia (c) and microsclerotia (e) as compared to *Verticillium dahliae* conidia (d) and microsclerotia (f) (Source: Zou et al. 2020).

Verticillium Stripe Symptoms in Canola (*Brassica napus*)

Early symptoms are typically seen in fully podded canola, which include unilateral striping on the plant stem (Figure 3a and 3b), and root cross section discoloration or "starburst" grey pattern (Figure 3e), typically in late August dependent on seeding date. More mature symptoms include stem shredding, necrosis and plant lodging. Visual microsclerotia on the stem indicate the presence of *V. longisporum* (Figure 3c and 3d; Tiedemann et al. 2019; Hwang et al. 2024). Although potential yield loss still needs to be investigated under Canadian conditions, some studies in Europe report yield losses as high as 50% while others have reported minimal damage (Novakazi et al. 2015; Dunker et al. 2008; Tiedemann et al. 2019). Tiedemann et al. 2019 estimated that if 60% of plants showed visual disease symptoms of *V. longisporum*, yield loss was between 10 to 50%. In a recently published Canadian paper, Cui et al. 2025 showed that there was a large range of between 17 to 83% impact on yield in single plants due to *V. longisporum* but that this did not translate to the same yield impact at a plot level.

Figure 3. Visual symptoms indicative of Verticillium stripe in the field in canola. Unilateral, brown striping on a green stem (estimated 4 weeks before harvest) - ie. Typically early/mid August dependent on seeding date (a and b). Visible microsclerotia on the stem (c and d). Grey root cross section in a "starburst" pattern (e).

Verticillium longisporum Detection through qPCR from Manitoba's Provincial Canola Disease Survey

qPCR Results from Manitoba Canola Disease Survey 2025 (n=68)	
# of Fields Below 10,000 copies/g	30
# of Fields Between 10,000-200,000 copies/g	23
# of Fields Above 200,000 copies/g	15

Table 1. qPCR Results from Manitoba Canola Disease Survey 2025 (n=68). Note: 38 out of 68 fields were tested and confirmed for *V. longisporum* presence through qPCR. Early visual symptoms (ie. brown striping) in some of the remaining 30 fields were recorded as visual incidence and not confirmed by qPCR, but this is likely due to lack of microsclerotia formation and crop stage at the time of surveying. The threshold of the qPCR negative was <10,000 copies/g tissue of DNA.

Figure 4 (a and b). Verticillium stripe tolerant canola hybrids versus not tolerant hybrids in strip trial from an above (a) and in-plot (b) vantage point.

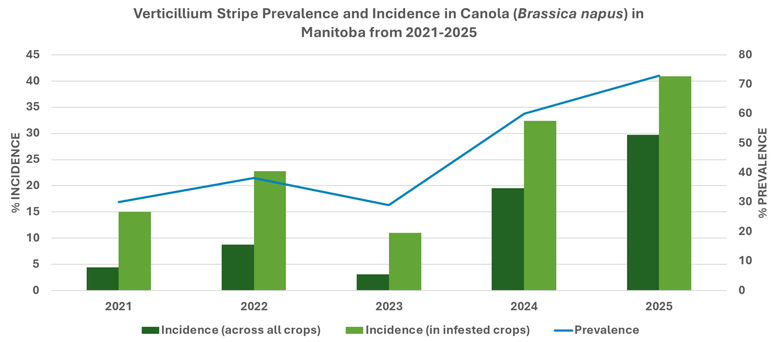


Figure 5. Provincial disease survey visual results of Verticillium stripe prevalence and incidence in MB from the years 2021 to 2025.

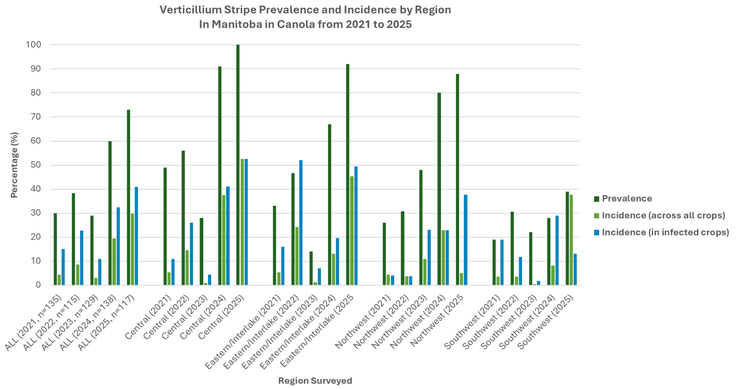
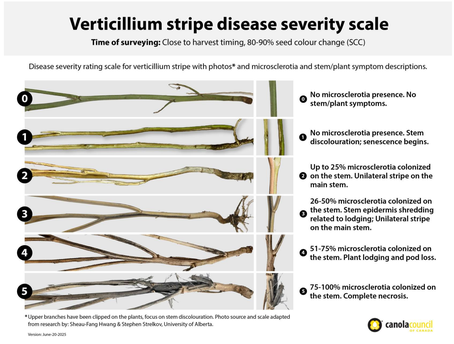


Figure 6. Verticillium stripe visual results of prevalence and incidence by region in Manitoba from the years 2021 to 2025.

Rating Verticillium Stripe Severity at the Field Level

V. longisporum symptoms in *B. napus* differ between the greenhouse and field conditions. Whereas significant stunting of growth and rapid colonization in roots could be detected between 28 to 35 days in greenhouse conditions, symptoms are typically undetectable in field conditions until 4 weeks before harvest with early striping (Tiedemann et al. 2019). Therefore, the confirmation and rating of *V. longisporum* at the field level can present a challenge with its late-season symptomology coinciding with potential desiccation and harvest of the crop. Several field severity rating scales for *V. longisporum* in canola have been proposed and research is being conducted to correlate disease severity with impact on yield (Figure 7).



In the Field: Individual Plant Scale (1-9) (VS = Verticillium Stripe) (Zhang et al. 2025)	In the Field: Plot Level (1-9) (VS = Verticillium Stripe) (Zhang et al. 2025)
1=no VS infection	1=no VS infection
3=low VS infection ("stem striping, microsclerotia in up to 25% of epidermis, stem pith or single branches completely colonized with microsclerotia")	3=low VS infection: <30% of plants showing symptoms)
5=medium VS infection (epidermis easily peeled away, "50% of stem or stem pith colonized with microsclerotia")	5=30-50% of plants with symptoms
7=strong VS infection ("complete discoloration of stem; epidermis fibrous or only fibrous remnants of the epidermis present; up to 75% of stem colonized with microsclerotia")	7=strong disease infection: 50-70% of plants with symptoms
9=severe DS infection ("premature dying off; complete discoloration of stem interspersed with microsclerotia (>75%)")	9=>70% of plants with symptoms

Figure 7. Several field severity rating scales have been proposed for verticillium stripe in canola (highlighted are the Canola Council "Verticillium stripe disease severity scale" (a) and Zhang et al. 2025 severity rating scales with both individual plant and plot level ratings (b)).

Challenges faced with a disease severity rating scale in the field have included but are not limited to:

- Timing of severity assessments in proximity to harvest/desiccation
- Quantifying in the field the % of microsclerotia infection (ex. 50 versus 75%)
- Fast progression of symptoms depending on environmental conditions (even within a week timeframe)
- Plants within the field being at different stages, exhibiting different progression of symptoms – needing a "field-level" assessment as well

Future Genetic Resistance and Standardized Screening of Canola Hybrids

Several companies have released internally tested, tolerance ratings for canola hybrids and verticillium stripe (Figure 8). Two examples are shown below, where hybrids within a company's portfolio are rated in relation to each other. At this point, there is no standardized testing options or industry checks, such as with blackleg (*Leptosphaeria maculans*) for variety registration. The two figures below of company-rated verticillium stripe tolerance are publicly available. Most, if not all, groups offering canola hybrids for sale have been doing internal assessments for verticillium stripe and it is highly recommended to talk to your seed rep or retailer if verticillium stripe is a challenge on your farm.

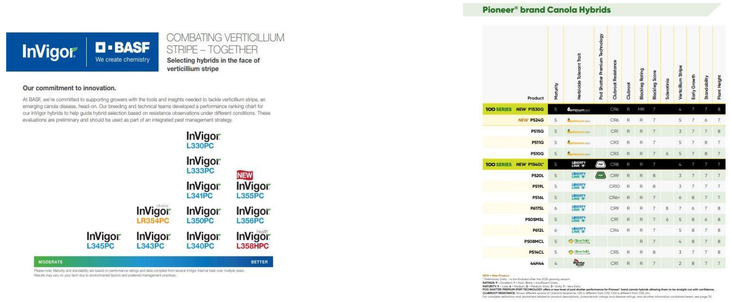


Figure 8. Company tested verticillium stripe ratings of currently offered canola hybrids from BASF | InVigor portfolio and Pioneer® brand Canola Hybrids portfolio.

Completed, Ongoing, and Future Research of *Verticillium longisporum* in the Canadian Context

Currently, there are a number of both basic/fundamental and applied research projects focusing on the biology of the pathogen, genetic resistance in canola, and favorable conditions of the disease, as well as optimization of disease management through on-farm investigations, as detailed in Figure 9. The Canola Council of Canada's Verticillium Stripe Steering Committee Research Priorities are as follows:

- Estimation of impact on yield based on severity of infection from verticillium stripe
- Interaction and relationship between the blackleg and verticillium stripe
- Discovery of novel genetic resistance against verticillium stripe
- Role and impact of environment on *V. Longisporum* resistance
- Impact of harvest management techniques on disease severity
- Assessment of verticillium spore loads in Canadian soils and their correlation with disease severity

Future research directions can also include but are not limited to a better understanding of the A1 and D1 lineages in VS, potential impact of nematode root wounding on infection, non-Brassica hosts as reservoirs in the rotation, and many others. Management practices that are being focused on in research include but are not limited to: swathing versus straight cut canola impact on spore load, potential fungicide efficacy, early soil detection, effects of rotation, and impacts of the soil microbiome.

COMPLETED	ONGOING
Verticillium Disease Etiology and Nursery (Drs. Dilantha Fernando and Mario Tenuta)	**Digging out the Unknown: Finding Resistance against Verticillium stripe in Canola** (Dr. Dilantha Fernando)
Verticillium Stripe – Disease Management (Drs. Sheau-Fang Hwang and Stephen Strelkov)	**Investigating the Conditions Favoring Verticillium Stripe Development and Yield Losses in Canola** (Drs. Sheau-Fang Hwang and Fouad Daayf)
Genetics and Genomics of Brassica-Verticillium Interaction (Dr. Hossein Borhan)	**A Comprehensive Survey of Verticillium Stripe and Establishment of a Disease Nursery in Morden, Manitoba** (Dr. Ahmed Abdelmagid)
Rapid Evaluation of Verticillium stripe Resistance in Canola (Dr. Xuehua Zhang)	**Impact of Synergistic Interaction between V. longisporum and L. maculans on Canola Yield** (Dr. Hossein Borhan)
	Comparative Analysis of Verticillium longisporum Lineages in the Canadian Prairies: Safeguarding Canola Production (Dr. Zhongwei Zou)
	*NEW: **Genetic Insights from Pennycress: Enhancing Canola Resistance to Verticillium longisporum** (Dr. Hossein Borhan)
	*NEW: **Identifying Novel Genetic Sources of Resistance to Verticillium stripe using Synthetic Brassica napus Lines** (Dr. Harmeet Chawla)
	Manitoba Canola Growers Association: On-Farm Trials Focused on Verticillium Stripe Management (https://canolagrowers.com/canola-on-farm-research-program/)

Table 2. Completed and ongoing research focused on verticillium stripe in the Canadian context.

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