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Performance of Soybean-based Rotations in Manitoba: Root Diseases

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Introduction

Soybean root rot diseases pose a significant threat to soybean production worldwide, impacting yield and quality. In Manitoba, where soybean cultivation has gained momentum due to the development of new early-maturing soybean varieties and increasing market demand, soybean root rot diseases has become a critical concern for farmers, industry, and agricultural researchers.

Root rot diseases are caused by various pathogens, including fungi and oomycetes, which infect the root system of soybean plants, leading to reduced nutrient uptake, stunted growth, and ultimately yield loss (Bradley et al. 2021). To evaluate the impact of rotation on soybean root rot, the effects of five crop rotations were evaluated near Brandon, MB, from 2014 to 2023.

Materials and Methods

In 2014, a field experiment was established on a Newdale clay loam soil north of Brandon, Manitoba to investigate five rotations ranging in duration from 2 to 3 years and consisting of various combinations of soybean (S), wheat (W) and canola (C) (Table 1).

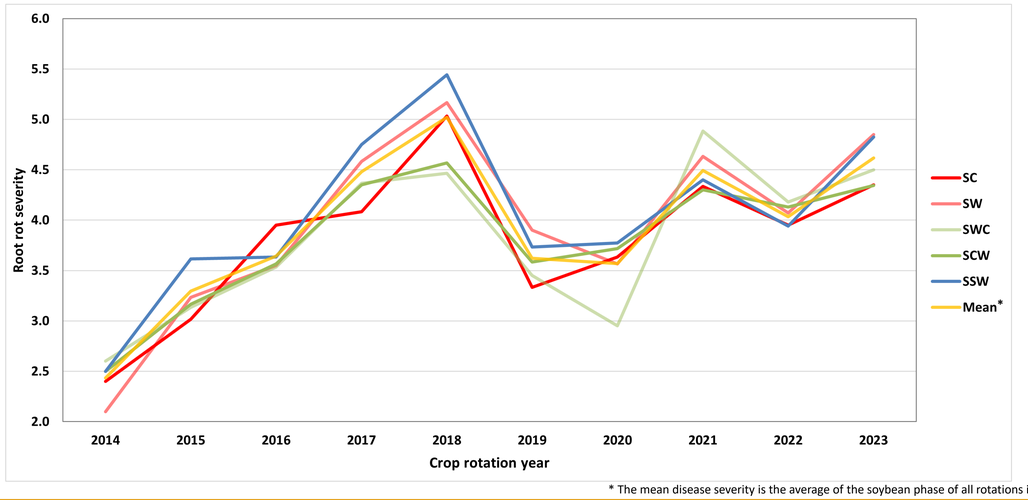
Table 1: Rotation Treatments

2-year:	soybean-canola	SC
	soybean-wheat	SW
3-year:	soybean-wheat-canola	SWC
	soybean-canola-wheat	SCW
	Soybean-soybean-wheat	SSW

Treatments were arranged in a Randomized Complete Block Design (RCBD) with each phase of each rotation present in each year (Fig. 1). All crops were direct-seeded into stubble and managed using generally-accepted agronomic practices.

During the crop rotation study, soybean roots were collected and assessed for root disease incidence and severity. The rating scale ranged from 0 (no disease) to 9 (death of the plant).

Figure 1. The impact of rotation treatments on soybean root rot disease severity over the period from 2014 to 2023. Disease severity was assessed using a rating scale ranging from 0 (no disease) to 9 (plant death).



* The mean disease severity is the average of the soybean phase of all rotations in a given year.

In the laboratory, root tissue was surface sterilized and processed for *Fusarium* spp. identification, which include microscopic examination, morphological characterization, and molecular confirmation.

Results and Discussion

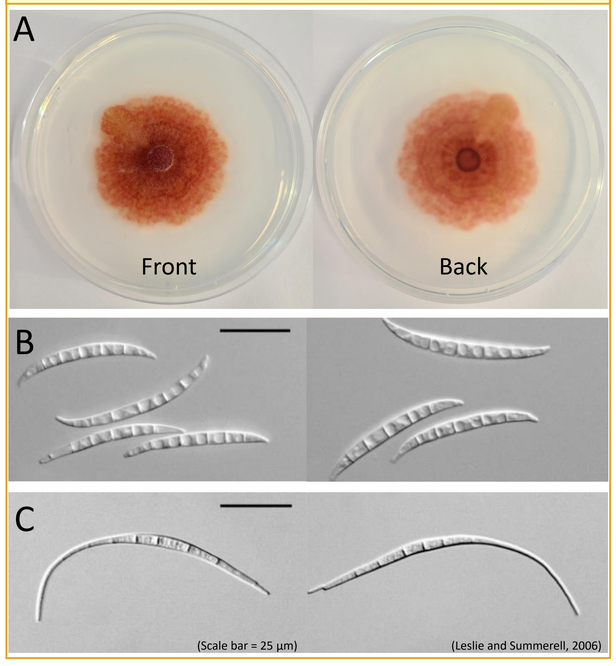
Throughout the study years, soybean root rot was consistently observed across all treatments and in every plot (Fig. 1).

A trend of increased root rot severity was observed in all the treatments in the first five years, followed by a reduction in the sixth year, possibly due to dry early-season conditions. Subsequently, root rot severity gradually increased in the last five years of the study.

The SCW, SWC, and SC rotations demonstrated lower mean disease severity in select years. This suggests that the inclusion of canola and the order of rotation may contribute positively to disease management.

Interestingly, the stacked rotation of soybean (SSW) and the tight soybean rotation with wheat (SW) showed higher root rot ratings in select years.

Figure 2. Figure 2. The colony characteristics of *Fusarium graminearum* grown on a potato dextrose agar medium, showing its distinctive reddish pigments (A). Macroconidia of *F. graminearum* (B) and *F. equiseti* (C).



This suggests that the sequence of soybean and wheat crops in these rotations may impact disease severity.

The microorganisms most frequently isolated from roots of infected plants belonged to *Fusarium* spp., including *F. oxysporum*, *F. redolens*, *F. avenaceum*, *F. equiseti*, *F. acuminatum*, and *F. graminearum* (Fig. 2).

Summary

In the crop rotation study, *Fusarium* spp., which are currently causing diseases in economic crops in Manitoba, were identified as the most prevalent root rot pathogen in soybean.

The study highlights that differences in disease severity patterns may take several years to become apparent in rotation studies, and the long-term trends are yet to be determined.

The effect of rotation length and crop sequence on root rot suggests that the tight rotations and stacked soybean rotations show a trend of increased root rot severity in select years.

As we continue our research into 2024 and beyond, we aim to further investigate the complex relationships between different soybean rotation regimes and soybean root rot, contributing to the development of sustainable agricultural practices and enhanced crop resilience.

References:

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