Pioneer® brand 45S51 Sclerotinia Resistant Canola Field Verification Study

Problem Description

Sclerotinia stem rot (*Sclerotinia sclerotiorum*), also known as white mold, is the primary disease affecting canola crop production in the prairies of Western Canada. Sclerotinia is a soil-borne pathogen that has a wide host range and can infect such crops as sunflowers, soybeans, dry beans and peas.

Infection in canola occurs during the canola flowering period from airborne spores and is highly dependent upon weather conditions at the time of infection with moist conditions favoring disease development. Infected plants prematurely ripen and initially exhibit pale grey lesions on leaf and stem tissue. Disease incidence of this pathogen can differ from year to year, and yield losses can be quite variable. Yield losses on an individual field basis have been reported to range from 5 to 100%. Generally, yield loss due to sclerotinia in canola is estimated to be half the level of infection. For example, if a field exhibited 50% infection, then the estimated yield loss is 25%.

Protective foliar fungicides are used to prevent sclerotinia infection in canola and are effective if applied at the appropriate time (prior to disease infection) but normally are only economical under high disease pressure. The average market price per acre for a sclerotinia fungicide in western Canada in 2009 was $20.00 per acre, not including the application cost (Stratus Agri-Marketing Canola Fungicide Survey, 2009). Determining if a fungicide application is warranted is difficult in most years, as sclerotinia infection can be variable, future environmental conditions unpredictable and fungicides must be applied proactively to maximize control of this disease.

Pioneer® brand 45S51 is the first commercially available canola hybrid that exhibits increased genetic resistance to sclerotinia infection. This technology, developed through traditional plant breeding techniques, impedes sclerotinia disease development and offers growers a new management tool against this disease. 45S51 is the first product to be commercialized from Pioneer Hi-Bred's sclerotinia resistance breeding efforts. Its unique mode of action reduces disease development and disease transfer in canola and is a combination of:

- Reduction in disease transfer to the stem and
- Reduction of disease severity in infected stems.

Research Objectives

The objectives of this study were:

1. to evaluate the effects of growing a sclerotinia resistant canola hybrid versus a non-resistant canola hybrid in the presence and absence of foliar fungicides, and
2. to determine the effect of these treatments on sclerotinia field severity (SSFS) and grain yield under naturally occurring field infestations of sclerotinia.

Sclerotinia disease infection on canola stems in a susceptible hybrid (left) versus a resistant hybrid – 45S51 (right)[1].

Study Description

Large strip-plot research trials were established at 16 grower managed locations in 2008 and 30 locations in 2009 across the three prairie provinces of Western Canada. Two canola hybrids were planted in 5 acre blocks at each location (Table 1).

Table 1. Treatment codes, hybrids, treatment and fungicide application stage included in the trial.

Treatment Code	Pioneer® brand Hybrid	Genetic Response to Sclerotinia	Treatment	Application Stage
45S51 UTC	45S51	Resistant	Untreated	N/A
45S51 F	45S51	Resistant	Foliar Fungicide*	30 - 50% Bloom
45H26 UTC	45H26	Susceptible	Untreated	N/A
45H26 F	45H26	Susceptible	Foliar Fungicide*	30 - 50% Bloom

* Foliar fungicides included in the study were: Lance® (boscalid); Proline® (prothioconazole); Rovral® Flo (iprodione) and Quadris® (azoxystrobin) at labeled rates.

Pioneer 45S51 was used as the sclerotinia resistant canola hybrid, while Pioneer 45H26 was used as the sclerotinia susceptible canola hybrid (Table 1). Each hybrid was split into 2.5 acre plots, and half of the hybrid received a fungicide treatment while the other half was left untreated (Figure 1).

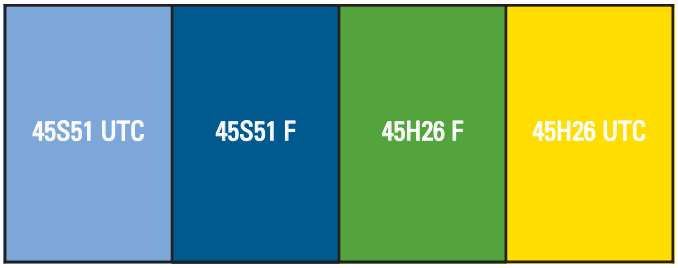

Figure 1. Schematic of trial design at individual locations.

Trials were planted by grower cooperators in commercial canola fields using conventional seeding equipment (i.e. air seeder), and fungicide treatments were applied using field-scale spraying equipment. Trials were evaluated after the canola flowering period to determine sclerotinia disease incidence and severity, which was then used to calculate sclerotinia field severity (SSFS).

Disease incidence and severity were determined by sampling 250 plants per treatment as the canola crop reached physiological maturity. Main stem disease infection of individual plants were rated on a 1 to 9 scale, with 1 designating a plant that exhibited complete premature ripening/death due to sclerotinia and 9 corresponding to a plant that had no visual symptoms of sclerotinia (Figure 2).

Figure 2: Rating scale (1 to 9) for main stem infection due to sclerotinia.

Disease severity and incidence observations were combined to give a sclerotinia field severity value (SSFS, 0-100) using a modified version of the formula described by Bradley et al. (2004):

SSFS = ((%disease incidence x disease severity) / 5).

Because sclerotinia was not present at all locations, only those locations with a sclerotinia field severity (SSFS) rating of 10% or greater were in the susceptible check (45H26 UTC) included in the analysis of the study. Consequently, there were 6 locations in 2008 and 13 locations in 2009 that met this criterion (Appendix, Table 2).

All treatments were taken to yield (bu/acre), and yield data were corrected to 10% moisture. SSFS and yield data were analyzed with S-Plus statistical software, utilizing a linear mixed model in which the fixed effect was hybrid treatment and the random effect was location.

Results and Discussion

What was the effect of foliar fungicide treatment on sclerotinia field severity (SSFS)?

Overall, the results of the study indicate that a foliar fungicide treatment reduced sclerotinia field severity in both Pioneer® brand 45S51 and 45H26. Disease severity was reduced to a greater degree in 45H26, as it is more susceptible to sclerotinia than 45S51 (Figure 3).

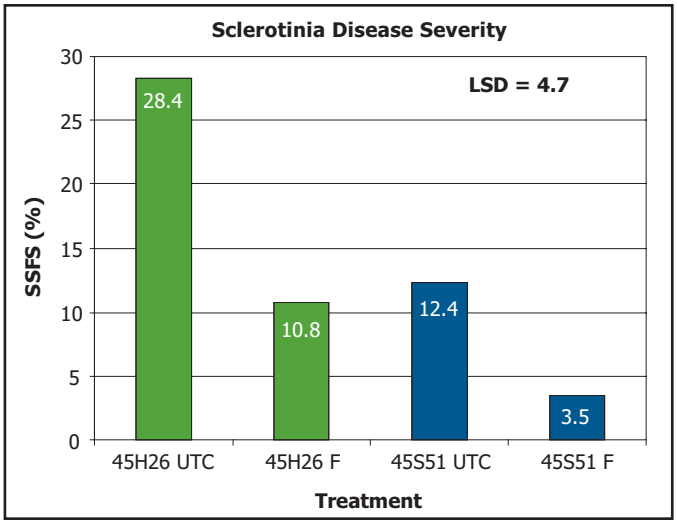

Figure 3. Sclerotinia Field Severity (SSFS) results averaged across locations for the individual treatments. N=19 locations across Western Canada, 2008 - 2009.

Sclerotinia field severity (%) gives an indication of the percentage of plants that are prematurely ripening due to sclerotinia disease infection. Although the use of a sclerotinia resistant canola hybrid such as 45S51 will not eliminate sclerotinia disease infection or the need for a fungicide under high disease pressure, there was a 56.2% reduction in SSFS when using 45S51 in the absence of a fungicide (45S51 UTC) compared to its susceptible counterpart (45H26 UTC).

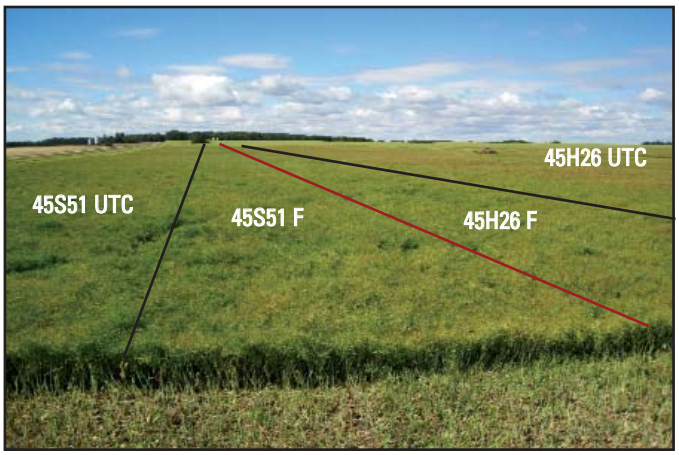

Figure 4. 45S51 Sclerotinia Verification Field Trial; Bjorkdale, SK, 2009 showing the four individual treatments. Compare plants on the **far left** (45S51 untreated showing resistance to sclerotinia infection) to those on the **far right** (45H26 untreated, plants prematurely ripening due to sclerotinia).

What was the effect of foliar fungicide treatment on yield?

A foliar fungicide application in the presence of sclerotinia increased yield of both canola hybrids (45H26 and 45S51), but provided a greater benefit on 45H26 (Figure 5). Results suggest that the two hybrids have a similar yield potential when disease is absent, but that the greater susceptibility of 45H26 to sclerotinia can result in greater yield loss when disease is present and a fungicide is not applied. In the absence of a

fungicide application, there was a 5.4% (or 2.6 bu/acre) increase in yield when a resistant hybrid (45S51 UTC) was used in the presence of sclerotinia compared to a susceptible hybrid (45H26 UTC) (Figure 5). Conversely, when a fungicide was used the yields between the two fungicide treatments (45H26 F and 45S51 F) were not statistically different (p=0.5).

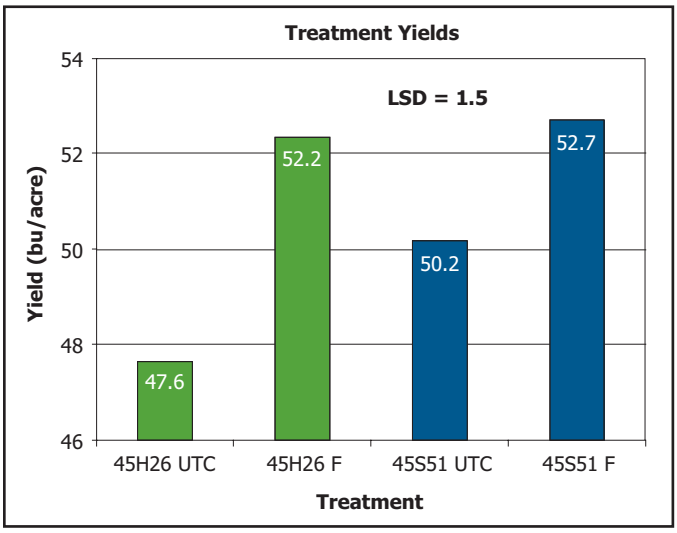

Figure 5. Grain yield (bu/acre) averaged across locations for the individual treatments included in the study. N=19 locations across Western Canada, 2008-2009.

Summary

Because Pioneer® brand 45S51 has proven to significantly reduce sclerotinia development, selecting this hybrid is an effective management tool for growers in combating the disease. Although 45S51 does not necessarily replace a fungicide application, it has demonstrated a significant ability to reduce sclerotinia field severity and protect yield when the disease is present. On a scale of 1 to 9, with 9 being "highly resistant," 45S51 rates a 5, or "moderately resistant" (Figure 6).

The conditions in 2009 were conducive to a later onset of sclerotinia development in canola fields in Western Canada. Anecdotally, it was observed that Pioneer 45S51 provided late season protection both in the absence and presence of fungicide application, as its level of resistance was maintained throughout the growing season. It was also noted that 45S51 reduced disease incidence similar to that of a single application of a protective foliar fungicide on sclerotinia susceptible genetics. However, the Sclerotinia Checklist developed by the Canola Council of Canada along with your local weather forecast should still be the major factors to consider when making spraying related decisions for sclerotinia. The future of Pioneer's sclerotinia resistant breeding efforts is focused on providing improved traits in improved products, resulting in higher levels of sclerotinia resistance and increased yields.

References

Bradley, C., Endres, G., Hanson, B., McKay, K., Halvorson, M., Porter, P., and LeGare, D. 2004. 2003 Evaluations of Fungicides for control of Sclerotinia Stem Rot of Canola in North Dakota and Minnesota. NDSU Extension Service Report. PP-1263.

[1]Photo courtesy of Igor Falak, Pioneer Research Scientist.

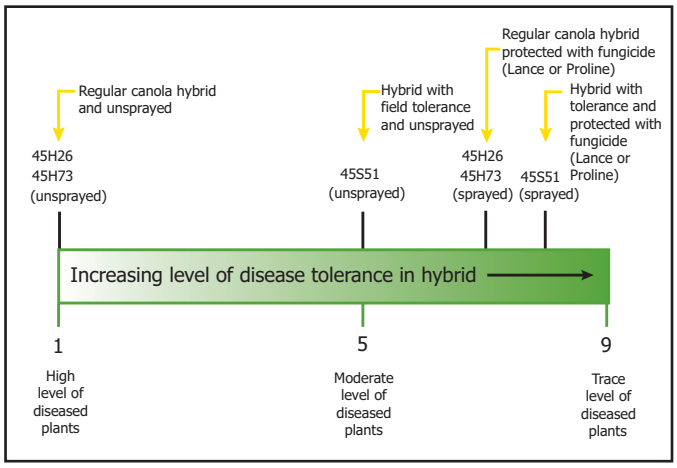

Figure 6. Disease resistance of hybrids given different levels of sclerotinia pressure.*
*This diagram does not account for extreme years when two fungicide applications are recommended by manufacturers.

Appendix

Table 2. Location, year and fungicide used in the field study.

Location	Year	Fungicide Used
Somerset, MB	2008	Lance®
Ashville, MB	2008	Rovral® Flo
Russell, MB	2008	Lance
Elm Creek, MB	2008	Lance
Kamsack, SK	2008	Lance
Canora, SK	2008	Quadris®
Ashville, MB	2009	Lance
Crystal City, MB	2009	Proline®
Dauphin, MB	2009	Lance
Forrest, MB	2009	Proline
Hamiota, MB (1)	2009	Lance
Hamiota, MB (2)	2009	Lance
Kenville, MB	2009	Lance
Minto, MB	2009	Proline
Neepawa, MB	2009	Lance
Roblin, MB	2009	Lance
Lake Lenore, SK	2009	Rovral Flo
Rosthern, SK	2009	Proline
Bjorkdale, SK	2009	Proline