Field performance of Brassica napus L. spring canola hybrids with improved resistance to Sclerotinia stem rot

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Abstract

Sclerotinia stem rot (SSR) is an important disease of spring canola caused by Sclerotinia sclerotiorum **(**Lib.) de Bary. Foliar fungicides are applied to manage this disease with variable success. More than fifteen years of SSR testing and breeding resulted in the registration in 2008 of Pioneer Brand® 45S51, the first canola hybrid with improved field resistance to SSR. A further improved hybrid, Pioneer Brand® 45S52, was registered in 2010. The objectives of this research were to estimate potential field performance of 45S51 and 45S52 with regards to resistance to SSR in various environments.

SSR testing of 45S51 was conducted in three field scenarios from 2007-2010. Large scale on farm trials, where 45S51 was tested alongside susceptible canola products, were conducted under natural field conditions across a wide range of geographies. Small replicated research yield plots which were grown at multi-locations and in some cases were irrigated. As well, hybrids were subjected to extreme disease pressure in row trials which received mycelial-based inoculum under controlled field conditions. Some of the large scale trials and research plot trials had fungicide sprayed controls. Data on disease incidence and disease severity were collected from which a disease index calculation SSFS (Sclerotinia sclerotiorum field severity) was performed. Extensive field testing of 45S52 was initiated in 2008 research trials.

Large scale on farm trials over four years in Western Canada indicated a >50% overall reduction of SSFS in 45S51 vs. susceptible canola products. Research plot trials under semi-natural conditions showed a similar reduction of SSFS in 45S51. Finally, artificially inoculated row trials gave results which were consistent with on farm performance.

While 45S51 field resistance did not match efficacy of fungicide control in the field, field resistance of 45S52 was notably higher. The best control of Sclerotinia was attained by applying fungicide on products with improved Sclerotinia resistance. The introduction of 45S51 and 45S52 has provided farmers with a new tool to manage SSR in North America.

Introduction

All currently grown cultivars of canola are susceptible to SSR although some variation exists in lodging resistance (Kutcher et al., 2001). Jurke and Fernando (2002) studied effects of different morphological types on limited variation in field performance. Bradley et al. (2006) confirmed lack of genetic variation in canola against Sclerotinia during a comprehensive study on 6 canola varieties. SSR activities at Pioneer Hi-Bred commenced in late 1980's with germplasm acquisition and testing with the resistance trait being developed via modified S1 per se recurrent selection effort over 10 Cycles from 1996 to 2005 (Falak et al., 2011). The main objective of these studies was to quantify SSR reaction and yield of resistant and susceptible canola products under SSR pressure as well as compare results to plot/row trial results. A second objective was to quantify the impact of fungicide efficacy on SSR and yield.

Materials and Methods

All disease ratings were conducted on individual plants at the growth stage 80 (Canola Council of Canada) on the scale 1-9, where 1 was a prematurely dead plant and 9 was a plant without symptoms (Falak et al., 2011). Disease incidence (SSDI) as well as disease severity (SSDS) were calculated. The SSDS data which is based only on infected plants was transformed into a 0 to 5 scale to enable a calculation of SSFS (Sclerotinia sclerotiorum field severity). SSFS was used to quantify impact of disease as per Bradley et al.(2004). SAS statistical software was employed utilizing a linear mixed model in which the fixed effect was hybrid treatment and the random effect was location.

Large scale on farm evaluation

Large strip-plot research trials were established at 51 grower managed locations from 2007 to 2009 in Western Canada. Two canola hybrids, 45H26 susceptible and 45S51 resistant, were planted in 2 ha blocks at each location with 1 ha of each hybrid treated with fungicides at recommended rates at the 30 - 50% flowering stage. Five samples of 50 individual plants from uniform parts of the field were rated for Sclerotinia damage. Twenty two locations met a threshold of 10% SSFS and were used in this study. Large strip-plot research trials were established at 46 grower managed locations in 2010 in Western Canada. Two susceptible canola hybrids, 45H28 and 45H29, and two resistant hybrids, 45S51 and 45S52, were planted in 1 ha blocks. Twelve locations met the threshold of 10% SSFS and were utilized in the analysis.

Research plot trials

Replicated research plot trials were established at 52 locations from 2007 to 2010 in Canada. Three susceptible canola hybrids (45H26, 45H28 and 45H29) and two resistant (45S51 and 45S52) hybrids were planted in plots (1.45m wide x 6.0m long). Ascospore inoculum was applied at flowering and fungicide treatments were performed on check entries. Fifty plants per plot were rated for Sclerotinia symptoms. Twenty one locations met the threshold of 10% SSFS and were utilized in the analysis.

Row trials with mycelium-based inoculum

Single row trials with 5 designated hybrids were conducted from 2007 to 2010 in one location in Ontario using methodology described by Falak et al. (2011). All plants in the row were rated for Sclerotinia symptoms.

Results

Large scale trials 2007-2009

Overall, the results of the study indicate that a fungicide treatment significantly reduced Sclerotinia field severity in both 45S51 and 45H26 (Figure 1). Untreated 45S51 had a higher level of disease compared with treated 45H26. Untreated 45S51 showed a 54.4% reduction in SSFS compared to untreated 45H26.

A foliar fungicide application in the presence of Sclerotinia increased yield of both canola hybrids 45H26 and 45S51. In the absence of a fungicide application, there was a 5.1% increase in yield when a resistant hybrid 45S51 was used vs. susceptible hybrid 45H26 (Figure 1). When a fungicide was used the yields between the two fungicide treatments (45H26 and 45S51) were not statistically different.

Large scale trials 2010

45S51 and 45S52 reduced disease impact relative to 45H29 in the field by 62.9% and 68.1% respectively (Figure 2). In the same trials, 45S51 and 45S52 increased yield by 1.4% and 4.9% respectively vs. 45H29.

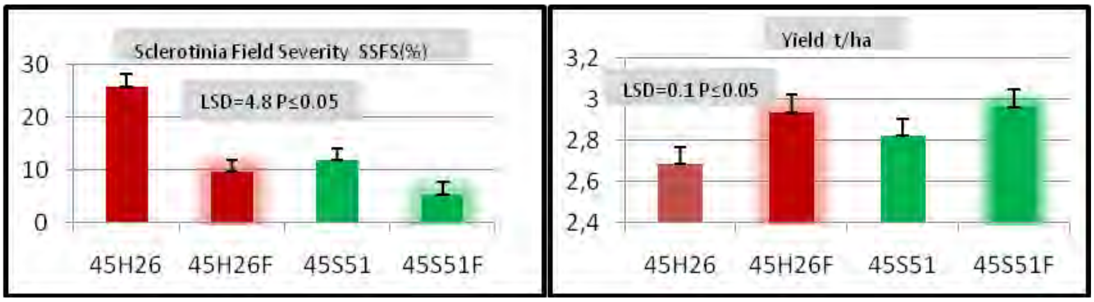

Figure 1. Large scale trials 2007-2009 SSFS vs. Yield

Sclerotinia Field Severity (SSFS) results across locations in Western Canada for the individual treatments. Susceptible Hybrid 46H26 vs. Resistant Hybrid 45S51 and fungicide treated 45H26F/45S51F. SSFS (N=22 locations 2007 – 2009); Yield (N=19 2008-2009).

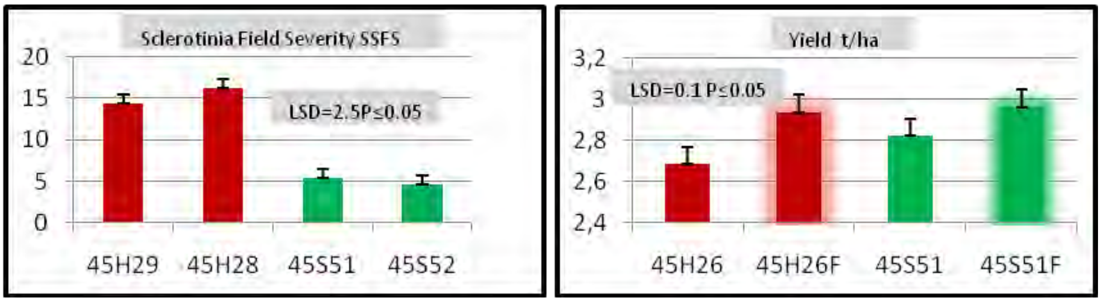

Figure 2. Large scale trials 2010 SSFS vs. Yield

Sclerotinia Field Severity (SSFS) results across locations. Susceptible Hybrids 45H29/45H28 vs. Resistant Hybrids 45S51/45S52. N=12 locations across Western Canada, 2010.

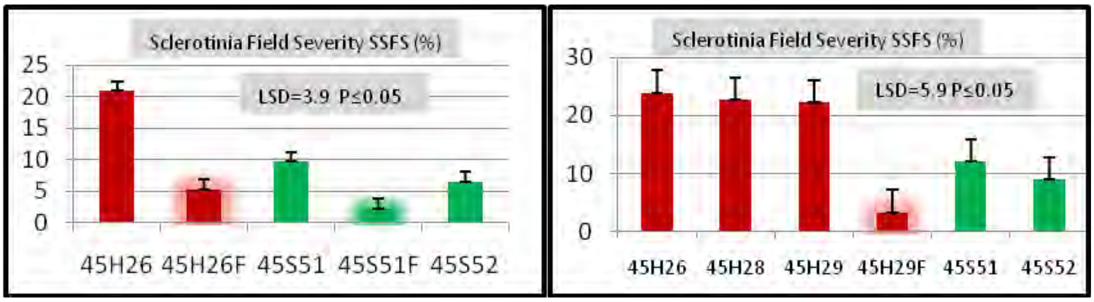

Figure 3. Research plot trials 2007-2010

Sclerotinia Field Severity (SSFS) results across locations and years 2007-2009 left and 2010 right. Susceptible Hybrids 45H26, 45H28, 45H29 vs. Resistant Hybrids 45S51,45S52 with targeted fungicide treatments 45H26F, 45S51F,45H29F. (N=25 2007-2009; N=8 2010)

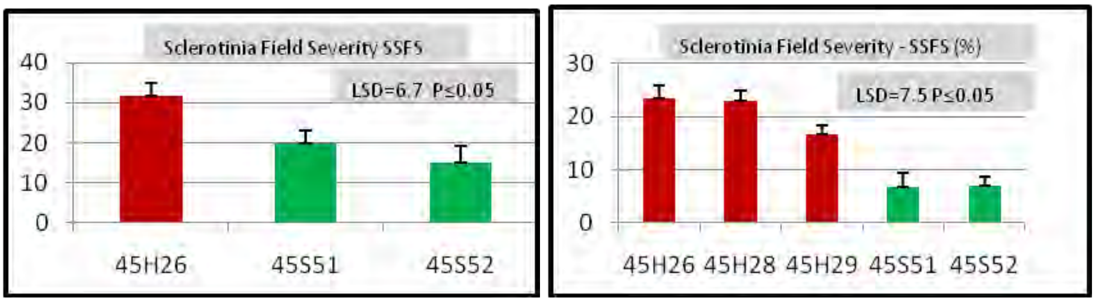

Figure 4. Row trials with mycelium-based inoculum

Sclerotinia Field Severity (SSFS) 2007-2009 left and 2010 right. Susceptible Hybrids 45H26, 45H28, 45H29 vs. Resistant Hybrids 45S51 and 45S52

(N=6 2007-2009; N= 2 2010)

Research plot trials 2007-2010

45S51 and 45S52 reduced disease impact relative to 45H26 in the field by 55.3% and 68.9% respectively in 2007/2009 trials (Figure 3). In the same trials, fungicide spray reduced disease by 74.9% on 45H26 relative to the untreated control. In 2010, 45S51 and 45S52 reduced disease by 49.8% and 62.3% relative to 45H26.

Row trials 2007-2010

45S51 and 45S52 reduced disease impact relative to 45H26 in the field by 37.3%/71.2% and 52.9%/69.9% in 2007-2009/2010 testing (Figure 4).

Discussion

Two large-scale plot studies conducted from 2007 to 2010 represent on farm performance of Sclerotinia resistant products with natural inoculum. Overall results showed >50% reduction in field severity of 45S51 against susceptible hybrids. 45S52 showed further reduction in field severity as well as increased yield.

45S51 breeding and commercialization in 2008 triggered the largest SSR characterization effort in the history of canola in Canada. Field performance across years and environments, as well as performance in the market in Sclerotinia-favorable growing seasons 2009/2010, demonstrate stability of disease resistance across a wide geography and natural populations of Sclerotinia sclerotiorum. Differences in research plot trials/row trials were predictive of large scale performance with tested hybrids.

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