Response of Canola Cultivars to *Sclerotinia sclerotiorum* in Field and Controlled Environments

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INTRODUCTION

Sclerotinia stem rot (SSR), caused by *Sclerotinia sclerotiorum*, causes economic losses to canola (*Brassica napus* or *B. rapa*) fields grown in Minnesota and North Dakota. Currently, no canola cultivars are marketed as having resistance to SSR. The primary method of managing SSR is with fungicides, which are an added expense to growers. The objectives of this study were to identify canola cultivars that are less susceptible to SSR, and to identify an efficient greenhouse or laboratory screening method that correlates with field reactions.

MATERIALS AND METHODS

Field studies. Canola cultivars were evaluated for resistance in field trials located at Carrington, ND (2001, 2002, 2003, and 2004) and Red Lake Falls, MN (2001, 2003, and 2004). The canola trials were grown under mist-irrigation systems and inoculated with *S. sclerotiorum* ascospores to promote disease infection and progression. Canola plants were evaluated for SSR incidence and yield.

Controlled environment studies. Canola cultivars were evaluated for SSR resistance using a petiole inoculation technique (PIT), a detached leaf assay (DLA), and an oxalic acid assay (OAA). For the PIT, a leaf was removed from a 4-leaf canola plant leaving the petiole attached to the stem. The petiole was inoculated with a *S. sclerotiorum*-infested plug inside a micropipette tip. Plants were evaluated daily for several days, and an area under disease progress curve (AUDPC) was calculated. For the DLA, leaves removed from canola plants were placed in a moisture chamber and inoculated with a *S. sclerotiorum*-infested plug. Lesion diameter was measured 24 hours after inoculation. For the OAA, canola plants cut and removed at the soil line were placed into test tubes containing a 40 mM solution of oxalic acid for 48 hours. A sample of the oxalic acid was then removed from each tube and absorbance was measured with a spectrophotometer.

Statistical analyses. The general linear model procedure (PROC GLM) in SAS (SAS Institute, Inc., Cary, NC) was used for statistical analysis. Fisher's protected least significant difference (LSD) was used to compare means, where alpha = 0.05. Pearson correlations between field data and the greenhouse/laboratory data were conducted using SAS (PROC CORR Pearson).

RESULTS

Field studies. Incidence of SSR ranged from 15 to 43%, 4 to 23%, 48 to 90%, and 0 to 5% at Carrington, ND in 2001, 2002, 2003, and 2004, respectively (Tables 1 to 4). Incidence of SSR ranged from 34 to 77%, 11 to 76%, and 1 to 25% at Red Lake Falls, MN in 2001, 2003, and 2004 (Tables 5 to 7).

Controlled environment studies. Significant ($P \leq 0.05$) differences among cultivars occurred with the PIT and OAA, but not with the DLA (Table 8).

Correlations. Significant ($P \leq 0.10$) negative correlations were detected between data from the PIT trial and canola yield data from Carrington in 2001, 2002, and 2003, and Red Lake Falls in 2001. The significant correlation coefficients ranged from -0.48 to -0.76. No other correlations were significant.

CONCLUSIONS

The PIT appears to be an efficient and accurate (compared with field data) method of evaluating canola cultivars for resistance to SSR. Field evaluations made over multiple years or locations should be used in combination with the PIT method to measure SSR resistance in canola cultivars and to identify new sources of resistance.

Inoculating canola plots with ascospores.

Canola plots under mist-irrigation.

Girdling lesion from the petiole inoculation technique (left); Expanding leaf lesion from the detached leaf assay (middle); Canola stem immersed in an oxalic acid solution (right).

Table 1. Carrington, ND in 2001.

Cultivar	Incidence (%)	Yield (kg/ha)
Crusher	33	1395
Hudson	25	1860
Hyola 357	34	2709
Hyola 401	21	2992
IMC 204	32	2078
Invigor 2573	43	2859
Invigor 2663	34	2737
LG 3455	41	2284
Minot RR	32	2304
Pioneer 44A89	36	2257
Pioneer 46A76	23	2495
Q2	31	2394
Rider	27	2453
Roughrider	25	1942
Skyhawk	17	1969
SWP 9828000	15	2093
$LSD_{0.05}$	16	372
CV	32.2	9.7

Table 2. Carrington, ND in 2002.

Cultivar	Incidence (%)	Yield (kg/ha)
Crusher	11	914
Gladiator	16	1904
Hudson	17	1121
Hyclass 601	14	1661
Hyola 357	9	2116
Hyola 401	14	1928
IMC 204	12	1100
Invigor 2573	16	2298
Invigor 2663	4	2188
Invigor 2733	15	1458
LG 3455	9	1735
Minot RR	5	1701
Pioneer 44A89	18	1262
Pioneer 46A76	7	1664
Q2	23	1655
Rider	11	2182
Roughrider	5	1462
Skyhawk	5	1316
SWP 9828000	8	2129
$LSD_{0.05}$	10	390
CV	60.6	16.5

Table 3. Carrington, ND in 2003.

Cultivar	Incidence (%)	Yield (kg/ha)
Hyclass 601	48	1603
Hyola 357	61	1903
Hyola 401	55	2162
Invigor 2663	62	1745
LG 3455	53	1573
Pioneer 44A89	90	912
Pioneer 46A76	51	1538
$LSD_{0.05}$	18	537
CV	20.0	21.2

Table 4. Carrington, ND in 2004.

Cultivar	Incidence (%)	Yield (kg/ha)
Hyclass 601	1	3063
Hyola 357	3	2960
Hyola 401	1	2483
Invigor 2663	2	2986
LG 3455	1	3022
Pioneer 44A89	5	2466
Pioneer 46A76	0	2821
$LSD_{0.05}$	3	495
CV	22.5	12.7

Table 5. Red Lake Falls, MN in 2001.

Cultivar	Incidence (%)	Yield (kg/ha)
HyClass 601	25	1707
Hyola 357	18	1928
Hyola 401	11	1957
Invigor 2663	30	1826
LG 3455	29	1504
Pioneer 44A89	76	1343
Pioneer 46A76	21	1681
$LSD_{0.05}$	17	257
CV	38.6	10.1

Table 6. Red Lake Falls, MN in 2003.

Cultivar	Incidence (%)	Yield (kg/ha)
Hyola 357	29	1890
Hyola 401	34	1606
Invigor 2663	45	1549
LG 3455	40	1250
Minot RR	35	1349
Pioneer 44A89	77	1223
Pioneer 46A76	34	1199
SWP 9828000	42	1585
$LSD_{0.05}$	18	305
CV	29.4	14.2

Table 7. Red Lake Falls, MN in 2004.

Cultivar	Incidence (%)	Yield (kg/ha)
Hyclass 601	10	2545
Hyola 357	7	2825
Hyola 401	7	2743
Invigor 2663	4	2836
LG 3455	3	2378
Pioneer 44A89	25	2121
Pioneer 46A76	1	2167
$LSD_{0.05}$	9	334
CV	73.8	9.2

Table 8. Data from the controlled environment studies.

Cultivar	OAA[a]	PIT[b]	DLA[c]
Crusher	0.012	242	3.8
Gladiator	0.024	231	3.3
Hudson	0.022	195	2.2
Hyclass 601	0.011	85	2.1
Hyola 357	0.002	31	1.9
Hyola 401	0.009	89	2.9
IMC 204	0.014	274	6.2
Invigor 2573	0.014	134	3.4
Invigor 2663	0.025	219	3.3
Invigor 2733	0.033	126	4.1
LG 3455	0.003	128	4.7
Minot RR	0.020	211	3.6
Pioneer 44A89	0.007	248	2.9
Pioneer 46A76	0.005	227	2.5
Q2	0.010	128	4.2
Rider	0.014	215	2.9
Roughrider	0.013	265	3.1
Skyhawk	0.014	235	4.6
SWP 9828000	0.022	148	4.1
$LSD_{0.05}$	0.012	55	NS
CV	85.8	30.6	79.6