

Research to Minimize the Impact of Canola Blackleg in the U.S – 2004 Progress Report

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Background

Blackleg, caused by *Leptosphaeria maculans*, is a reemerging disease of canola in North Dakota. Short crop rotations and the development of more aggressive *L. maculans* strains may be partially responsible for the reemergence of the disease. Because of the growing threat of blackleg to canola in the major production region in the U.S., research was initiated in 2004. The objectives of the research were to: i) establish a blackleg nursery in North Dakota for screening cultivars and experimental lines for resistance; ii) evaluate northern canola cultivars and experimental lines for blackleg resistance against highly aggressive and variable *L. maculans* populations in University of Georgia blackleg nurseries; and iii) evaluate fungicides for management of blackleg.

Materials and Methods

North Dakota blackleg nursery. A blackleg nursery was established near Langdon, ND, on a grower's farm with a history of blackleg. Two different trials were conducted at the blackleg nursery. One trial evaluated canola seed company entries for resistance to blackleg (60 total entries), while the other trial evaluated University of

Georgia breeding lines (56 total entries). Infected canola stubble was spread throughout the plot areas to promote heavy disease pressure. The experimental design of each trial was a randomized complete block with four replications. Plots were evaluated for blackleg severity on 30 August 2004 by cutting stems of 10 plants per plot and rating using a 0 to 5 severity scale.

University of Georgia blackleg nurseries, 2003-2004 -- Invitations were sent to seed companies and canola breeding programs producing canola for production in the northern U.S. to submit lines for testing in the Georgia nurseries planted in October 2003. The seed arrived well past the normal planting time for the northern Georgia nursery and useful data was not obtained at that site. Three groups of lines were obtained in time for normal planting at the southern Georgia site at Plains. The rating scale used to evaluate lines is based on external symptoms of blackleg as follows:

- 0 = no externally visible symptoms
- 1 = 1 plant to 8% of the plants lodged, dead or with obvious basal canker
- 2 = 8 to 20% of the plants lodged, dead or with obvious basal canker
- 3 = 20 to 35% of the plants lodged, dead or with obvious basal canker
- 4 = 35 to 50% of the plants lodged, dead or with obvious basal canker
- 5 = 50 to 65% of the plants lodged, dead or with obvious basal canker
- 6 = 65 to 80% of the plants lodged, dead or with obvious basal canker
- 7 = 80 to 95% of the plants lodged, dead or with obvious basal canker
- 8 = over 95% of the plants lodged, dead or with obvious basal canker
- 9 = all plants dead without viable seed

University of Georgia blackleg nurseries, 2004-2005 – A selection of 24 lines that were evaluated in the 2004 North Dakota blackleg nursery were planted in two blackleg evaluation nurseries in Georgia in October 2004. These lines were selected to represent a series of blackleg reactions from very resistant to susceptible at the North Dakota site. Results of the evaluations at the Georgia sites will be available in May 2005, and will give a comparison of the reactions with different strains of the pathogen and under a longer growing season. They will be evaluated by the same procedure used in the North Dakota nurseries in addition to the procedure normally used in the Georgia evaluations.

Fungicide evaluations. Field plots were established at Langdon, Minot, and Carrington, ND, and Crookston, MN, for evaluation of fungicides for management of blackleg. A total of 17 different fungicide treatments (including standard and untreated controls) were evaluated for efficacy against blackleg on a susceptible canola cultivar (DeKalb

223). To promote heavy disease pressure, infected canola stubble was spread throughout the plot area. All foliar fungicide treatments were applied to canola at the 2- to 4-leaf stage. The experimental design of each trial was a randomized complete block with four replications. Plots were evaluated for blackleg severity by cutting stems of 10 plants per plot and rating using a 0 to 5 severity scale. Plots were swathed, harvested, and yields were determined.

Quadris fungicide X cultivar trial. A Quadris fungicide X cultivar trial was established at Langdon, Minot, and Carrington, ND, and Crookston, MN. Four canola cultivars differing in susceptibility to blackleg were either sprayed or not sprayed with Quadris fungicide for protection against blackleg. The experimental design of each trial was a randomized complete block with four replications. Plots were evaluated for blackleg severity by cutting stems of 10 plants per plot and rating using a 0 to 5 severity scale. Plots were swathed, harvested, and yields were determined.

Results

North Dakota blackleg nursery. Disease pressure was high, with disease severity ranging from 0.9 to 3.7 (Table 1). Several entries had disease severity ratings under a 2.0, which indicates that quality resistance to blackleg exists in some commercial cultivars and experimental lines. Disease pressure was also high among the University of Georgia canola breeding lines, with severity ratings ranging from 0.6 to 4.1 (Table 2). Resistance levels in these breeding lines were very good, with approximately 2/3 of the entries having severity ratings under a 2.0.

Table 1. Reaction of canola seed company entries to blackleg at Langdon, ND, in 2004.

Company	Entry	Severity (0-5) ^a	Incidence (%)	DSI (0-100) ^b
Agriprogress/Lembke	CH586	1.7	90	32
Agriprogress/Lembke	AP7910	1.7	80	33
Agriprogress/Lembke	AP 7978	2.9	100	58
Agriprogress/Lembke	AP 2227	1.7	93	32
Agriprogress/Lembke	APS 12	2.2	100	44
Bayer	EXP. 9060309	1.7	95	33
Bayer	EXP. 9060400	1.5	98	29
Bayer	EXP. 2050602	1.1	78	18
Bayer	EXP. 2050603	2.0	100	40
Bayer	EXP. 1040001	2.3	100	45
Bayer	EXP. 1040807	1.6	93	31
Bonis & Co.	BC 937-101	2.8	100	55
Bonis & Co.	BC 937-104	2.8	98	54
Bonis & Co.	BC 937-140	3.4	100	68
Bonis & Co.	BC S303L	3.5	100	70
Bonis & Co.	BC S305L	2.8	85	52
Bonis & Co.	BC 937-54	2.7	100	55
Bonis & Co.	BC 937-55	2.2	100	45
Bonis & Co.	BC H501R	1.8	90	35
Bonis & Co.	BC H503R	2.5	100	50
Croplan Genetics	HyClass 601	2.6	100	52
Croplan Genetics	Oscar	1.4	83	27
Croplan Genetics	Minot	2.7	95	52
Croplan Genetics	Crosby	2.7	100	53
Croplan Genetics	HyClass 767	2.5	100	50
Croplan Genetics	HyClass 2061	2.3	98	44

Croplan Genetics	HyClass 905	2.2	93	43
Croplan Genetics	HyClass 910	2.4	100	47
Dekalb	SW5207	1.6	98	32
Dow	Nex830CL	1.1	90	20
Dow	Nex824CL	1.3	93	25
Interstate Seeds	Hylite 618 CL	1.2	88	22
Interstate Seeds	Hyola 420	2.5	100	51
Interstate Seeds	Hyola 440	0.9	80	16
Interstate Seeds	Hyola 505 RR	1.2	85	22
Interstate Seeds	SW Marksman	2.3	95	45
Interstate Seeds	SW Patriot	1.4	78	24
Interstate Seeds	SW G5235 RR	1.8	95	35
Interstate Seeds	Hyola 357 Magnum	3.7	100	75

Table 1. Reaction of canola seed company entries to blackleg at Langdon, ND, in 2004. (cont.)

Company	Entry	Severity (0-5) ^a	Incidence (%)	DSI (0-100) ^b
Interstate Seeds	SW PL-7835 RR	1.8	85	33
Interstate Seeds	Z2409 RR	1.6	98	31
Interstate Seeds	SW 5246 RR	1.7	100	34
Interstate Seeds	HyLite 225 RR	2.0	95	39
Monsanto	X402	2.9	100	58
Monsanto	X403	1.2	98	24
Monsanto	X465	1.2	75	21
Monsanto	X500	3.7	100	74
Monsanto	X515	1.3	93	25
Monsanto	X545	1.1	80	18
Monsanto	X555	1.9	95	37
Monsanto	X565	1.4	93	25
Monsanto	X445	0.9	68	14
Monsanto	X505	1.2	85	23
Monsanto	X525	1.0	70	17
Pioneer	45H21	1.7	100	34
Pioneer	46H23	1.6	88	31
Check	AC Excel	2.6	90	50
Check	Defender	1.8	95	35
Check	Q2	1.6	90	29
Check	Westar	3.6	100	73
	<i>P > F</i>	0.0001	0.0816	0.0001
	LSD 0.01	1.0	NS	23.0
	LSD 0.05	0.8	NS	17.0
	LSD 0.10	0.7	17.0	15.0
	C.V.	28.2	15.7	32.2

^aBlackleg Disease Severity was rated by cutting 10 stems per plot and rating on a 0 to 5 scale, where:
0 = No penetration or noticeable infection of the stem; 1 = 1/4 of the stem circumference infected; lesion superficial; 2 = 1/2 of the stem circumference infected; some penetration; 3 = 3/4 of the stem circumference infected; significant penetration; 4 = stem completely girdled, but intact at the base; significant penetration; 5 = stem girdled at the base, constricted, dry and brittle, may be completely severed; plant dead

^bDisease severity index (DSI) was calculated by: (mean disease severity X % incidence)/5

Table 2. Reaction of University of Georgia canola breeding lines to blackleg at Langdon, ND, in 2004.

Entry	Severity (0-5) ^a	Incidence (%)	DSI (0-100) ^b
Flint	0.6	57	8
G00092	1.0	77	16
G00423	1.6	93	31
G01062	1.2	87	21
G01095	2.4	100	48
G01114	1.8	100	36
G01123D	1.9	100	37
G02088	2.2	100	45
G02103	1.2	90	22
G02544	1.3	97	26

Table 2. Reaction of University of Georgia canola breeding lines to blackleg at Langdon, ND, in 2004. (cont.)

Entry	Severity (0-5) ^a	Incidence (%)	DSI (0-100) ^b
G02551	2.5	100	50
G03002	2.5	100	51
G03036	1.5	100	31
G03037	0.9	73	14
G03040	1.2	90	22
G03047	1.3	93	24
G03501	1.8	100	36
G04015	1.5	97	29
G04016	2.2	97	42
G04017	2.5	100	50
G04018	2.1	100	42
G04019	2.6	100	52
G04021	2.0	100	39
G04022	2.4	100	47
G04024	1.5	100	29
G04025	1.2	87	21
G04026	1.4	87	25
G04027	1.9	100	37
G04028	1.8	97	35
G04029	1.2	87	23
G04030	1.4	83	25
G04031	1.5	100	30
G04032	1.5	93	29
G04034	0.7	60	10
G04036	1.6	93	29
G04038	2.0	100	39
G04041	2.1	100	43
G04052	1.9	100	39
G04060	2.2	97	42
G04066	1.8	100	37
G04068	1.1	83	18
G04073	1.4	87	24
G04074	1.5	100	30
G04075	1.3	87	24
G04076	1.2	80	20
G04083	1.1	73	18
G04084	1.5	100	30

G04085	0.9	70	14
G04086	1.2	77	21
G97042B	1.7	100	34
Cyclone	2.4	100	47
AC Excel	3.2	100	63
Defender	2.1	100	43
Q2	1.5	97	28
Westar	3.5	100	70
BL 188-20B	4.1	100	82
<i>P > F</i>	0.0001	0.0001	0.0001
LSD 0.01	1.0	26	21
LSD 0.05	0.7	19	16
C.V.	26.3	12.9	29.8

^aBlackleg Disease Severity was rated by cutting 10 stems per plot and rating on a 0 to 5 scale, where:

0 = No penetration or noticeable infection of the stem; 1 = 1/4 of the stem circumference infected; lesion superficial; 2 = 1/2 of the stem circumference infected; some penetration; 3 = 3/4 of the stem circumference infected; significant penetration; 4 = stem completely girdled, but intact at the base; significant penetration; 5 = stem girdled at the base, constricted, dry and brittle, may be completely severed; plant dead

^bDisease severity index (DSI) was calculated by: (mean disease severity X % incidence)/5

University of Georgia blackleg nursery. The lines from Table 2 and the 2003-04 University of Georgia nursery (Table 3) were classified by breeding program in each of nine

blackleg rating categories (Table 4). Based on the reactions of the standard cultivars in this test, the blackleg intensity was classed as moderate. Only lines from the Georgia breeding program were classified in the exceptional resistance category (rated 1.0 or less). This clearly illustrates the value of the recurrent selection under high blackleg pressure that has been used in the Georgia program for several years.

Table 3. Reactions of standard cultivars with a range of reactions to blackleg at Plains, Georgia, in the 2003-2004 season.

Cultivar	Mean Blackleg Rating*	Cultivar	Mean Blackleg Rating*
Flint	0.8	Glacier	4.7
Falcon	1.7	Cyclone	5.9
Dunkeld	2.3	Surpass 400	6.0
Oscar	2.6	Q2	6.3
Lolinda	3.9	Westar	8.0
		Quinta	8.7

0 (no symptoms) to 9 (all plants dead) Visual rating of external blackleg symptoms. See text for details of the rating scale.

Table 4. Number of canola lines from four breeding programs in each of nine classifications based on external symptoms of blackleg at Plains, Georgia, in the 2003-2004 season.

Mean Blackleg Rating*	Georgia	Monsanto	Croplan	Univ. of Idaho
1.0 or less	111	0	0	0
1.1-2.0	73	0	6	0
2.1-3.0	69	4	2	0
3.1-4.0	29	8	1	0
4.1-5.0	12	5	0	0
5.1-6.0	8	4	0	0
6.1-7.0	3	1	0	0
7.1-8.0	4	2	1	1
8.1-9.0	1	1	0	7
Total lines	310	25	10	8

* 0 (no symptoms) to 9 (all plants dead) Visual rating of external blackleg symptoms.

See text for details of the rating scale.

Selection of Georgia lines for earlier flowering and maturity.

The 50 lines sent from the Georgia breeding program are spring-type lines, but have been bred and selected for mild winter, long-season conditions.

These lines had never been tested under short-season summer conditions. We were pleased that four of these lines appeared to flower with the early- to mid-season lines in the adjacent test and another seven appear to match with the mid- to full-season lines. In addition to these 11, another 15 lines appeared to be segregating

for flowering, with the earliest matching the mid-season lines.

Side branches from the earliest plants of these 26 lines were bagged to prevent cross pollination and seed from these plants was planted for seed increase in southern Georgia in October 2004. The earliest and most productive of these (over 200 single-plant selections) will be tested again in the North Dakota nursery in 2005. The other 24 lines flowered and matured too late for production in the northern U.S.

Fungicide evaluations. Only the Langdon, ND, site achieved sufficient disease pressure for a valid treatment comparison. Disease severity ranged from 1.7 to 4.4 in the fungicide trial (Table 5). Six foliar fungicide treatments that resulted in canola yields significantly greater than the standard control (Helix Xtra seed treatment) were Pristine, Headline, JAU 6476, Amistar (same active ingredient as Quadris), A7402T, and Endura.

Table 5. Effect of fungicides on blackleg and canola yield at Langdon, ND in 2004.

Foliar Treatment	Fungicide Seed Treatment	Severity (0-5)	Incidence (%)	DSI (0-100)	Yield (lb/A)
Pristine	Helix Xtra	3.6	100	72	1264
Headline	Helix Xtra	3.2	95	61	1250
JAU 6476	Helix Xtra	3.2	95	61	1227
Amistar	Helix Xtra	3.3	95	64	1220
A7402T	Helix Xtra	3.8	100	76	1141
Endura	Helix Xtra	1.7	70	25	1131
Quilt	Helix Xtra	3.4	100	68	1081
Tilt	Helix Xtra	3.5	93	65	1048
Topsin	Helix Xtra	3.9	98	77	1041
Rovral	Helix Xtra	3.4	90	63	1028
None	Dynasty 20 g + Helix Xtra	3.3	100	67	1001
Ronilan	Helix Xtra	4.1	100	81	998
None	Helix Xtra	2.8	95	53	938
None	Dynasty 10 g + Helix Xtra	4.4	100	88	895
None	None	4.1	100	82	870
None	Topsin + Helix Xtra	2.4	100	47	865
None	Dynasty 20 g	3.1	98	61	732
LSD 0.05		1.0	11	22	190

Rates = Helix Xtra 23 fl oz/100 lb seed; Dynasty 10 or 20 g a.i./100 kg seed; Topsin (seed) 8 oz/100 lb seed; Endura 6 oz/A; JAU 6476 5.7 fl oz/A; Headline 9 fl oz/A; Rovral 14.4 fl oz/A; Amistar 1.8 oz a.i./A; Tilt 1.8 oz a.i./A; Quilt 1.8 oz a.i./A; Pristine 18 oz/A; A7402T 1.8 oz a.i./A; Topsin (foliar) 1 lb/A; Ronilan 16 oz/A.

All foliar fungicides applied at 2- to 4-leaf stage

DSI = Disease Severity Index calculated by: (mean severity X % incidence)/5 = DSI

Quadris fungicide X cultivar trial. Only the Langdon, ND, site achieved sufficient disease pressure for a valid treatment comparison. Disease severity ranged from 0.9 to 3.5 in this trial. No significant cultivar X

fungicide interactions were detected, therefore main effects only are presented. Pioneer 45H21 (Res.) and Hyclas 2061 (Mod. Res.) had significantly greater yield than Hyola 357 Magnum (Mod. Res.) and DeKalb 223 (Mod. Susc.) averaged over fungicide treatments (Table 6). Plots treated with Quadris fungicide had significantly less disease than untreated plots averaged over all cultivars (Table 7). However, yield differences between Quadris treated plots and untreated plots were not statistically significant averaged over all cultivars.

Table 6. Effect of canola cultivars on blackleg and yield of canola at Langdon, ND in 2004.

Cultivar	Severity (0-5)	Incidence (%)	DSI (0-100)	Yield (lb/A)
Dekalb 223	3.5	99	69	1212
Hyola 357	2.9	89	53	1423
HyClass 2061	1.4	49	23	1832
Pioneer 45H21	0.9	54	12	2017
LSD 0.05	0.8	21	19	226

Table 7. Effect of Quadris fungicide on blackleg and canola yield at Langdon, ND in 2004.

Fungicide	Severity (0-5)	Incidence (%)	DSI (0-100)	Yield (lb/A)
Quadris	1.8	60	31	1672
Untreated	2.5	85	47	1570
LSD 0.05	0.6	15	13	NS