What's New in Canola

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INTRODUCTION

Agriculture certainly is not a static industry – every year brings something new. The year 2003 was no exception. In this paper I will discuss three significant events from 2003 in canola: the discovery of clubroot disease in Alberta canola; herbicide tolerant canola that isn't all tolerant; and the birth of the Prairie Canola Variety Trial.

1. CLUBROOT OF CANOLA

Clubroot is a serious soil-borne disease of crucifer crops worldwide. The crucifer family includes field crops like canola / rapeseed, mustard, and vegetable cole crops such as cabbage, brocolli, cauliflower, radish and turnip. Clubroot is not a new disease in Canada – cole crops in eastern Canada and BC have suffered from clubroot for many years. Clubroot has even been occasionally found in Alberta gardens (Dr. I. Evans, personal communication) and fairly recently in a market garden near Leduc (Dr. R. Howard, personal communication). Clubroot also affects oilseed rape in Europe and Australia. However, clubroot has never been reported in canola in western Canada – until 2003.

In late August of 2003, a canola field near St. Albert was showing patches of early ripening plants that had shriveled seeds and odd roots. The problem was initially diagnosed by a sharp fertilizer agronomist, and then confirmed by Dr. Tewari (U of A) to be clubroot. This conventional tillage field has been in a wheat – canola rotation since 1997. Field inspections by at least two different pathologists (Dr. Evans and Ralph Lange) indicated that at least 90% of the field was infested. Dr. Evans also detected clubroot in five neighboring canola fields, and the agronomist had found trace levels in another field some distance away. With the disease confirmed and evidence that several more fields were infested, I organized a crude survey in the area to estimate the extent of spread. Thanks to volunteers from the Canola Council of Canada, the county of Sturgeon, and Alberta Agriculture, we managed to survey 70 canola fields in the area. Only two more fields with trace levels of clubroot were found. An additional four canola fields are likely infested from other reports and samples brought in by farmers. Also, clubroot was identified at Alberta Agriculture Crop Diversification North research farm. If the market garden near Leduc is included, the total number of clubroot infested fields is 13. This involves 4 areas around Edmonton, 4 different canola producers, the research farm and market garden. *In summary, clubroot was not isolated to a single field or area – but our survey indicates that it has NOT spread to most canola fields in that area.*

The organism that causes clubroot is Plasmodiophora brassicae Woronin. Although clubroot has been classified as a slime mold fungus in the past, more recently it is regarded as a protist. The pathogen infects the root, causing irregular galls (several pictures shown in presentation) to form that restrict the flow of water and nutrients to aboveground plant parts. Thus the symptoms will range from wilting, stunting, yellowing, premature ripening and seed shriveling. The life cycle is shown on the next page.

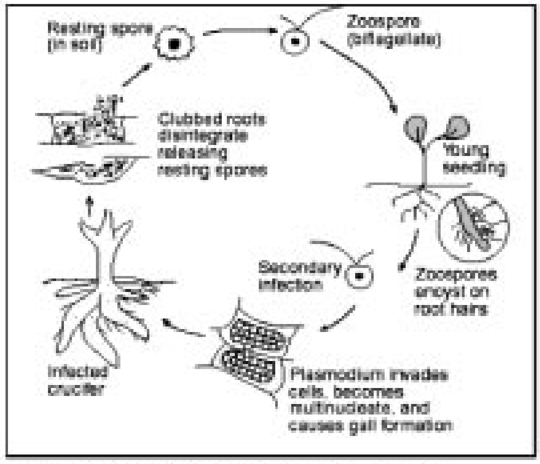

Figure 1: Life cycle of *Plasmodiophora brassicae*, the pathogenic fungus that causes clubroot (Source: Ohio State University).

The resting spores are extremely long lived – reports range from 10 to 20 years. Swedish research found that 17 years was needed before the disease subsided to non-detectable limits (Wallanhammer, 1996), and the half-life was 3.5 years. This is the most serious aspect of this disease from a management point of view. Once you have clubroot, you can't really expect to get rid of it completely. Fortunately, there are no airborne spores produced such as with sclerotinia or blackleg. However, the resting spores are capable of moving with soil transported by wind or water erosion.

The biggest influence on the severity of clubroot is the length of rotation break from canola. The discovery of a new disease in canola fields under short rotation should not be a surprise. Due to the longevity of the resting spores described above, rotation recommendations for infested fields are 5-7 years out of canola. Swedish research confirms that the frequency of canola in the rotation influences the incidence and severity of clubroot (Wallenhammar, 1996).

There are several soil conditions that are conducive to severe clubroot. Since the zoospores can actively swim in water, good soil moisture promotes disease development. Good soil moisture arises from ample spring rain, fine to medium textured soil with good organic matter, poor drainage and/or low areas. Acid soils (pH less than 6.1) also promote more severe clubroot. A recent report from France (Allard et al, 2003) found that 80% of fields with high clubroot infestation levels were acidic. This has important implications for the disease potential in Alberta since a significant part of the traditional canola growing area is acidic.

The canola yield loss from clubroot is significant. Swedish research (Wallenhammar et al, 1999) has reported that infestation of near 100% led to 50% yield loss, and lower infestations of 10-20% lead to 5-10% yield losses. This is similar to yield losses to sclerotinia stem rot, where a rule of thumb yield loss is about _ of the % infected stems. There is likely a large reduction in seed oil content in infected plants.

The key message for the canola industry (growers and agronomists) is that an ounce of prevention is worth a pound of cure. As a grower, I would try very hard to prevent or slow the introduction of clubroot to my fields. This involves following good crop sanitation – cleaning of dirt from equipment before transport or entry into fields, avoiding common untreated seed, and avoiding purchase of straw / hay bales from suspect areas. Most canola growers would complain that equipment cleaning is too impractical; however this practice is standard for potato growers. Although clubroot is not a true seed-borne pathogen (it does not infect any part of the seed), there is potential for seed transmission via seed contaminated with dirt and resting spores. This needs to be studied further. *The key preventative measure is longer rotation.* Even if clubroot somehow is introduced into your field, if you don't grow canola more often than every 4 years, the disease will probably stay at trace and thus economically insignificant levels.

Once you have clubroot, there aren't a lot of choices to manage it. We don't have any clubroot resistant canola varieties in Canada, and the few partly resistant varieties in Europe are fairly race specific and not very durable. We don't have any fungicides registered for seed treatment or in-crop spray in canola. There are some fungicides registered in other countries with good efficacy in cole crops, but the application method would need to be adapted to a field crop situation. Also, although the cost may be justified for high value cole crops, it is likely prohibitive for canola. Calcium cyanamide, an old N fertilizer form, provides good clubroot control in cole crops, but the high rates and cost would make it uneconomical in canola. Boron also has shown some promise in reducing clubroot disease, but again at fairly high rates. There may be potential to use fungicides / calcium cyanamide / boron at lower, affordable rates in canola by banding them below the seedrow. This topic needs to be researched. Liming acid soils has shown poor results for clubroot control in cole crops in eastern Canada (McDonald et al, 2002) and BC (Dr. J. Elmhirst, personal communication). Given the inconsistency and high cost, this is not an advisable option for canola.

Rotation away from canola for 5 to 7 years is the main strategy to cope with clubroot. This rotation strategy must also involve sanitation and soil conservation to keep contaminated soil from being transported to other clean fields. Reduced tillage has been reported to reduce clubroot severity in Norway (Ekeberg and Riley, 1997). Volunteer canola and susceptible weeds (crucifer weeds plus dock and hoary cress) must be controlled in other rotation crops. There are a few non-crucifer crops that are hosts (orchardgrass, red clover, perennial ryegrass and red-top or creeping bentgrass) so they also should be kept out of the rotation.

2. SUSCEPTIBLE PLANTS IN HERBICIDE TOLERANT CANOLA SEED

Over the past eight years, herbicide tolerant canola has become widely adopted. However, as with all new technology, there has been a learning curve for growers and the industry. First, there was the finding of multiple resistance due to pollen flow between fields (Hall et al, 2000), as was predicted in CFIA Decision Documents during the approval process. This has led to minor adjustments in volunteer canola management advice, such as the inclusion of phenoxy herbicides in spring pre-seeding herbicide mixes.

Then came the relevation that HT traits were contaminating certified canola seedlots, apparently due to impure breeder or foundation seedlots (Downey and Beckie, 2002; Friesen et al, 2003). The Friesen et al (2003) study reported HT trait contamination above 0.25% in 14 out of 27 unique CSGA numbered seedlots, whereas Downey and Beckie (2002) found 18 seedlots out of 80 were above 0.25%. The pedigree system in Canada strives for genetic purity by visual inspection (field and seed inspection) and prevention of contamination (rotation, isolation and land requirements). There are no mandatory genetic tests for purity under the Canada Seeds Act, and therefore no pedigree tolerances for HT contamination of seedlots because they are visually indistinguishable. The AOSCA international standard of 0.25% tolerance for "adventitious presence" in certified seed is the only applicable standard, although it was not developed for regulating genetically modified trait contamination. European standards for transgenic trait contamination of seed (0.3%) will likely come into force in 2004. Even these low contamination levels will be noticeable in certain field situations such as pre-seeding burnoff of volunteer canola or attempts to terminate poor canola crops due to drought. One important finding from both studies is that many certified seedlots are produced with zero or extremely low contamination. This suggests that the pedigree system works when uncontaminated breeder seed is used. Also certain companies appear to be voluntarily screening their certified seedlots for genetic trait contamination, thereby maintaining zero or extremely low contamination levels.

The Downey and Beckie study also identified a few seedlots of herbicide tolerant varieties that contained significant levels of susceptible plants. This finding did not get much attention compared to the HT trait contamination. Then in 2003, some producers growing certain Roundup Ready varieties complained that high levels of plants died after spraying in-crop with Roundup. Although there were outbreaks of cutworms and seedling blight that confounded diagnoses, tests on some of these seedlots showed unacceptable levels (30-50%) of susceptible plants. This year we learned that acceptable levels of susceptible plants in HT varieties are specified by the breeder during the registration process – however the registration office (CFIA) does have limits depending on the type of variety. Monsanto also has similar quality guidelines they require for varieties with the Roundup Ready trait. Synthetic varieties can be registered with up to 15% herbicide susceptible plants, hybrids up to 15%, and open pollinated types 3%. Unfortunately the allowable % of susceptible plants for each variety is not publicly available, nor is there mandatory testing of seedlots to ensure they meet the guidelines. The problem with high susceptible plants in certain seedlots this year was identified through farmer complaints, and registration has been cancelled for two varieties as a result.

The above situations indicate that our pedigree seed process needs refining to handle genetic trait contamination. Testing for undesired HT traits and susceptible plants in each seedlot should be standard practice if not mandatory, and this information should be available for producers before purchase or delivery of the seed. *Producers should always retain some seed samples of each lot after seeding* to allow testing for purity or vigour if problems develop in the field.

3. PRAIRIE CANOLA VARIETY TEST

This year marks the birth of a canola variety adaptation testing program called the Prairie Canola Variety Trial (PCVT). In the past, canola variety adaptation or regional tests were conducted by agriculture departments in each prairie province. This regional testing added to the 2 or 3 years of variety performance data generated during the registration process ("coop data"). However declining government funding has put pressure on these regional trials for a number of years. In Alberta, entry fees were introduced in the mid-90's to help fund the program. When regional variety testing funds were discontinued in Saskatchewan in 2003, several key industry players pushed for a prairie wide canola system based on the Alberta model using entry fees. Discussions with the canola industry led to the birth of "Prairie Canola Variety Trial", which is funded mainly by the canola seed industry, and secondarily by growers and provincial governments. The Canola Council of Canada administers the program.

In many ways, this new system will be an improvement. The previous situation suffered from different protocols between provinces, lack of statistical measures, and duplication of sites near provincial borders. Thus the PCVT provides standardized protocols, high trial quality requirements, and reduces unnecessary duplication. The data will be presented with statistics so that true differences can be determined. Perhaps some of the shortcomings are: multi-year summaries will not be available; not all companies and thus not all marketed varieties are represented.

The 2003 trials were conducted by seed companies, governments and independent research contractors in three growing season zones across the prairies: short, mid and long. The trials involve replicated small plots to evaluate the genetic performance of varieties being marketed. They do NOT assess the performance of varieties under the various herbicide tolerant systems – doing this would confound the variety effect with herbicide efficacy which depends on the site's weed spectrum, spray timing, etc.

The results will be published in a variety of publications and with different levels of detail. For example, in Alberta, the PCVT zone summaries will be included with the annual variety description factsheet for cereals and oilseed (Agdex 100/32). The variety performance at individual locations will be published in the Canola Digest. The main difference that producers will notice between the new PCVT summaries, and the previous summaries in Agdex 100/32 are: there are 3 maturity zones rather than the 6 agro-climatic areas; there are 3 columns of maturity for each zone rather than one provincial average; the oil contents will not be shown; and the Least Significant Difference (LSD) is shown at the bottom of each zone yield column. The LSD should be emphasized – it is the yield difference needed to be real (95% confidence) rather than random variation. The new and old summaries are shown below.

HYBRID	SYNTHETIC	OPEN POLLINATED	Specialty oil	Organization	Current Name	Maturity +/- days from 46A65: short, +/- days	mid, +/- days	long, +/- days	YIELD: short-7 ST.YR	mid - 12 ST.YR	long-11 ST.YR	Overall Average	Height: +/- inches compared to 46A65	Lodging Resistance: rating +="better"	WCC/RRC data: BLACKLEG RATING
				Conventional					% yield of 46A65						
		√		Pioneer Hi-Bred	46A65	0	0	0	100	100	100	100	0	0	R
√				ADVANTA SEEDS	Y0276	2	0	0	104	108	104	106	4	0	R
		√	√	Monsanto Canada Seeds	PR6450*		1	0		89	97	93	1	0	R
√				Pioneer Hi-Bred	46H02	1	0	1	108	119	117	116	2	0	R
		√		SEED DIRECT INC.	95CH01		2			94		94	4	1	MR
		√		SVALOF WEIBULL	SW WIZZARD		1	0		104	109	106	3	1	R
				Clearfield											
		√		Brett-Young Seeds	8045CL	1	-1	1	89	84	91	88	1	0	MR
		√		Cargill Seeds	1604		2	3		96	94	95	2	1	MR
		√		Pioneer Hi-Bred	46A76	5	2	2	97	102	96	98	4	1	R
		√		SASK WHEAT POOL	Cougar CL	2	1		94	96		95	-1	0	R
				Liberty Link											
√				Bayer CropScience	5003	-7			103			103	-2	0	R
√				Bayer CropScience	5020	-2	-1	-1	123	122	130	125	1	0	R
√				Bayer CropScience	5030	2	1	1	118	131	126	126	7	1	R
√				Bayer CropScience	PH501-401*		0	0		127	127	127	6	1	R
				Roundup Ready											
√				ADVANTA SEEDS	512 RR	2	1	1	101	103	104	103	5	0	R
		√		Brett-Young Seeds	LBD422RR	1	0	-1	102	98	101	100	-1	0	R
		√		Brett-Young Seeds	LBD688RR	3	1	1	89	96	99	95	3	1	R
		√		Brett-Young Seeds	LBD644R	-1	-1	-1	107	103	104	104	-1	0	R
	√			Cargill Seeds	1812		2	2		101	97	99	4	0	MR
√				Cargill Seeds	1841	3	1	2	104	119	112	113	3	1	R
		√		Cargill Seeds	1849		1	0		101	99	100	0	0	R
		√		Cargill Seeds	1862	1	0		101	99		100	-4	0	MR
√				Cargill Seeds	7979-00*	4	1	2	92	100	104	100	4	1	R

FIGURE 2. New summary format with PCVT (draft data).

CANOLA

Variety	Irr. 1&2	Area (See Map) 1	2	3	4	5&6	Overall Average	Comp Mat	Ht. cm	Straw Strength	Comp Oil(%) Content	Blackleg Tolerance	Variety Type	Herbicide
	Yield as % of 46A65								ARGENTINE TYPE *Brassica napus*					
Herbicide Tolerant Varieties														
289 CL	XX	XX	XX	XX	95	XX	94	0	114	G	-0.4	1	OP	Clearfield
45A51[♣]	105*	104*	95*	102*	95	94	101	0	113	VG	0.3	3	OP	Roundup
45A54[♣]	XX	94	XX	95*	87	82	89	-1	106	G	-0.9	1	OP	Roundup
45A55[♣]	XX	94*	XX	98*	93	109	99	-1	105	G	-1.4	1	OP	Roundup
45A71[♣]	97	100	96*	84*	95	104	96	0	105	G	-1.3	3	OP	Clearfield
46A76[♣]	XX	111	106*	95*	100	106	104	3	114	EX	-1.1	1	OP	Clearfield
45H21	XX	XX	XX	XX	127	XX	115	-2	111	EX	0.2	1	HYB	Roundup
Canterra 1604	XX	XX	XX	XX	96	XX	96	3	111	EX	0.0	2	OP	Clearfield
Canterra 1812	XX	102*	XX	92*	100	104	100	2	106	EX	-1.0	2	SYN	Roundup
Canterra 1841	XX	XX	XX	XX	110	XX	110	1	116	EX	-0.7	1	HYB	Roundup
Canterra 1849	XX	XX	XX	XX	87	XX	90	1	108	VG	-0.8	1	OP	Roundup
Canterra 1862[f]	XX	86	96*	96*	93	91	94	0	94	VG	-0.6	2	OP	Roundup
Conquest	111*	98	107*	94	98	97	98	1	112	EX	-1.0	1	OP	Roundup
DKL3235[♣]	98*	96	101*	93	96	90	96	-1	100	G	-1.0	2	OP	Roundup
DKL34-55[▲]	XX	95	XX	90	101	96	98	0	108	VG	0.1	2	OP	Roundup
DKL35-25[▲]	XX	XX	XX	XX	105	XX	100	0	105	VG	0.5	2	OP	Roundup
DKL35-85[▲]	XX	XX	XX	XX	105*	XX	104	2	112	EX	-0.9	1	OP	Roundup
DS-Roughrider[▲]	XX	97	XX	99	91	105	96	2	110	EX	2.1	3	OP	Roundup
FieldKing 811RR	XX	XX	XX	XX	114	XX	105	2	112	EX	-0.3	1	OP	Roundup
Heritage[f]	XX	89	XX	86*	83*	84	86	0	106	VG	-1.4	2	OP	Roundup
Hylite 215 CL	XX	XX	XX	92*	90	85*	90	0	111	EX	-0.8	3	OP	Clearfield
Hylite 225 RR[▲]	XX	89*	92*	XX	95	95	95	-1	103	EX	-0.1	2	OP	Roundup
Hylite 243 CL	XX	XX	XX	88*	94	98	98	1	114	EX	-0.8	3	OP	Clearfield
Hyola 505RR	XX	XX	XX	XX	111	XX	111	2	122	G	-0.5	1	HYB	Roundup
Hyola 519RR	XX	XX	XX	XX	106	XX	106	1	110	G	-0.1	1	HYB	Roundup
IMC 109 RR	XX	XX	XX	88*	99	95*	99	-1	109	VG	-0.5	1	OP	Roundup
IMC 208 RR	XX	XX	XX	86*	97	XX	94	-1	109	VG	-0.5	1	OP	Roundup
InVigor 2573	XX	108	XX	128*	125	116	123	0	126	VG	-0.4	1	HYB	Liberty
InVigor 2663	XX	111*	122*	136*	128	115	128	-1	122	VG	-0.5	1	HYB	Liberty
InVigor 2733	XX	XX	XX	113*	118	117*	117	-3	106	VG	0.4	2	HYB	Liberty
Kelsey	XX	84	92*	87*	92	90	92	-2	109	EX	0.5	2	OP	Roundup
LBD561RR	XX	95*	XX	89*	98	97*	97	-1	104	VG	-1.6	2	OP	Roundup

FIGURE 3. Canola variety summary format from previous 2003 Agdex publication 100/32

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