The Management of Sclerotinia Stem Rot and Other Canola Diseases.

Clinton Jurke MSc
Canola Council of Canada

Outline

- Sclerotinia stem rot
- Blackleg
- Clubroot

Canola

- Canada's most valuable crop
- Estimated to provide $19,200,000CDN to the Canadian economy
- Currently three species:
  - *Brassica napus (99%)*
  - *B. rapa (<1%)*
  - *B. juncea (<1%)*

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Canola Growing Regions of Canada and The U.S.

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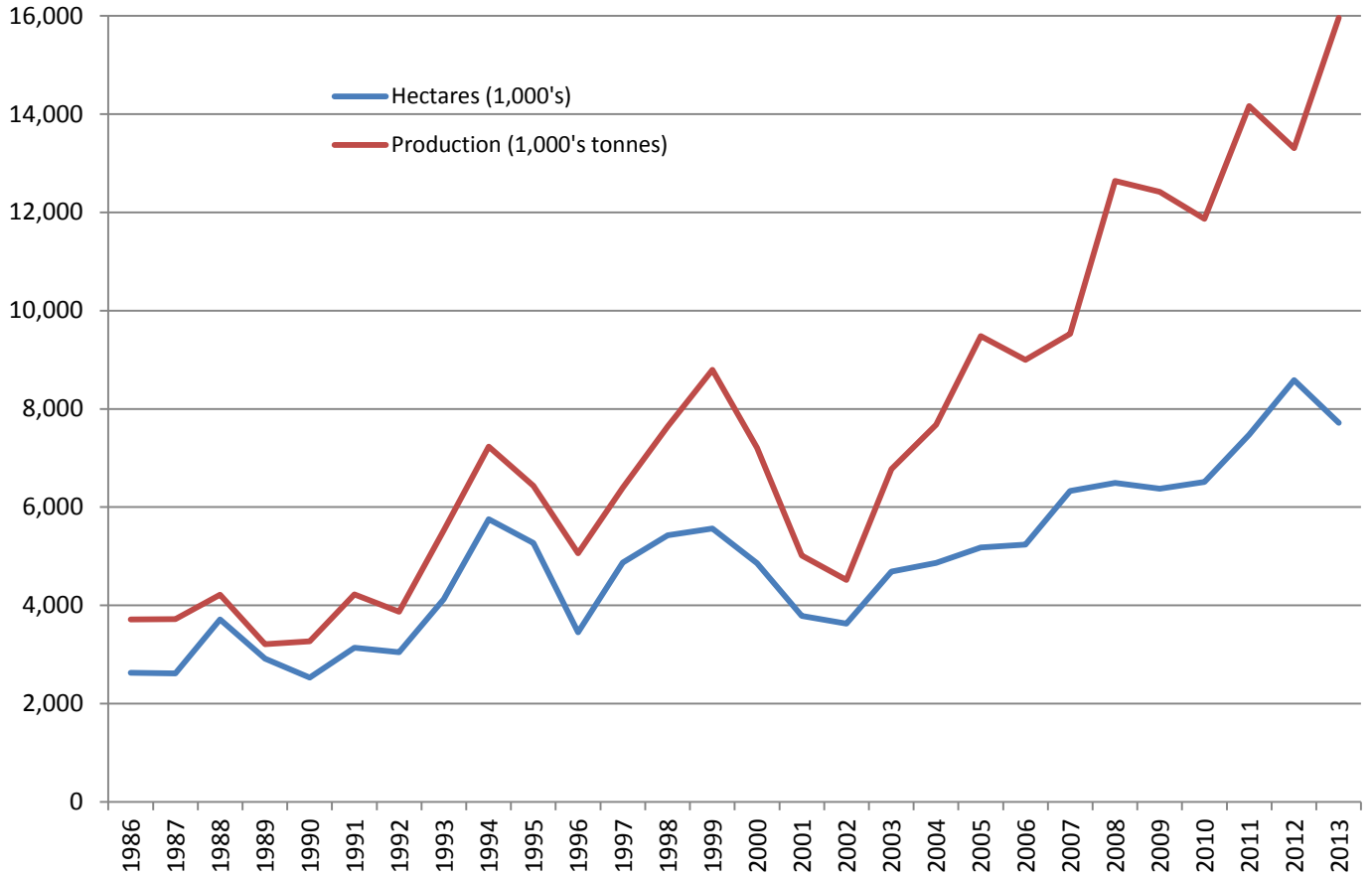
Canola Production in Canada



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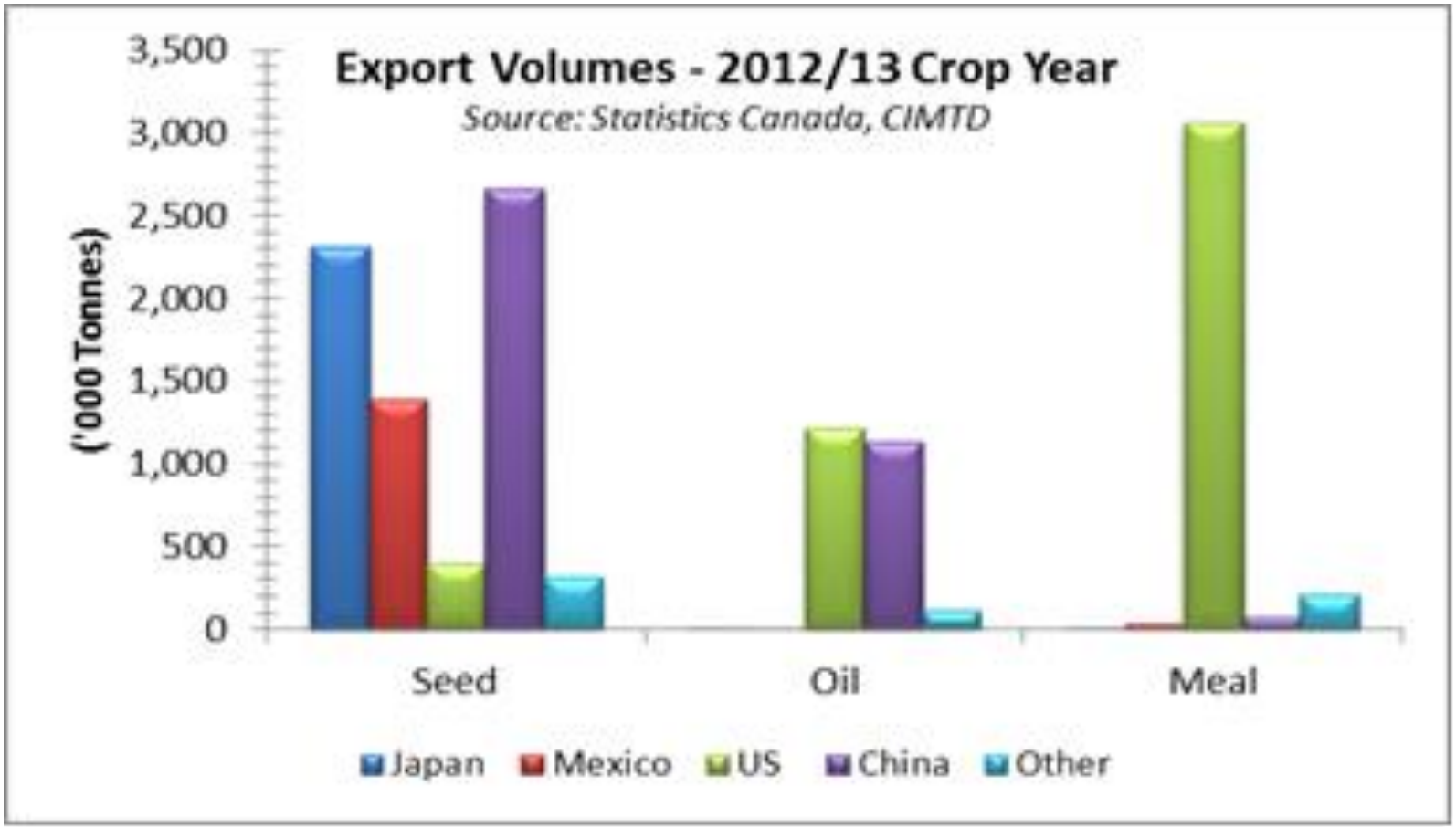
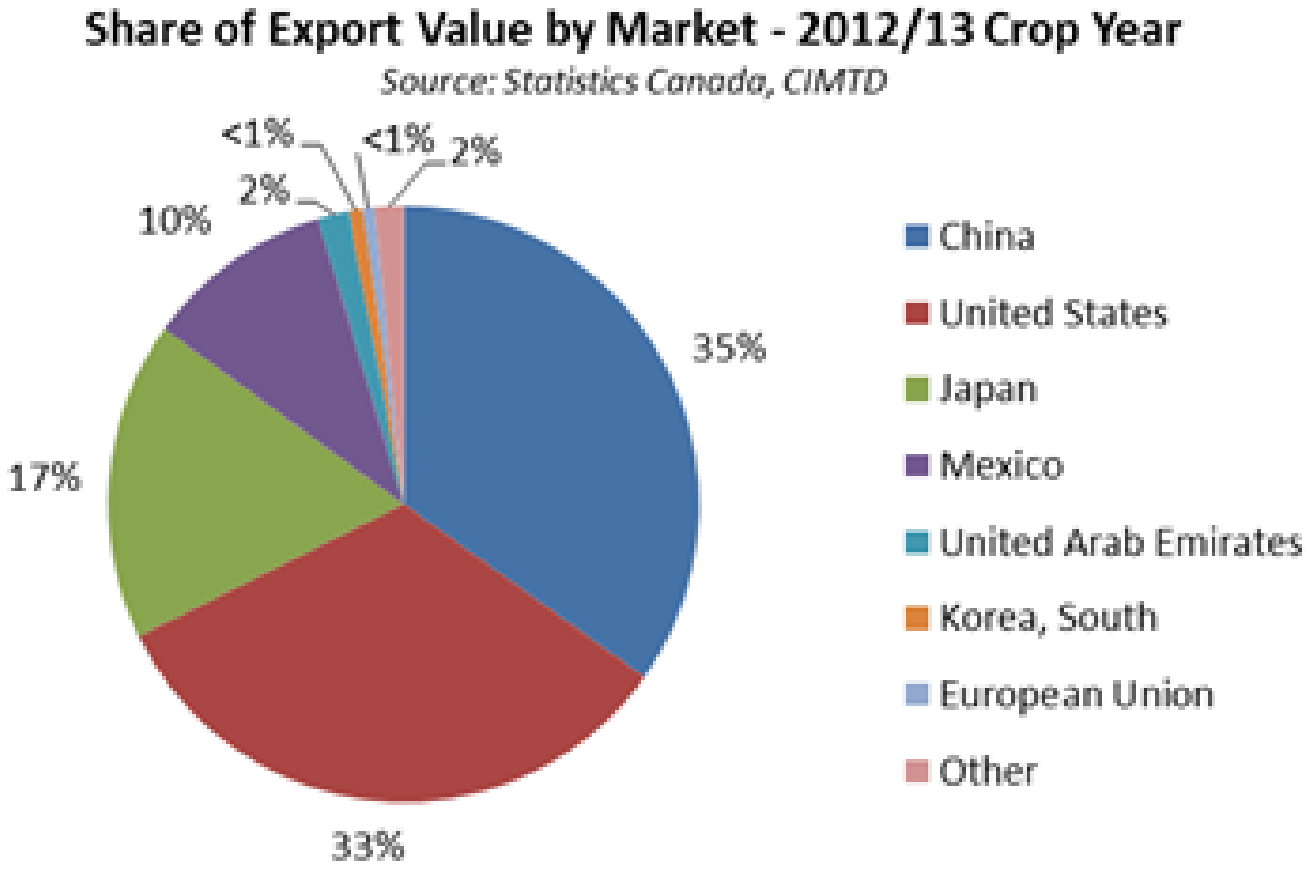
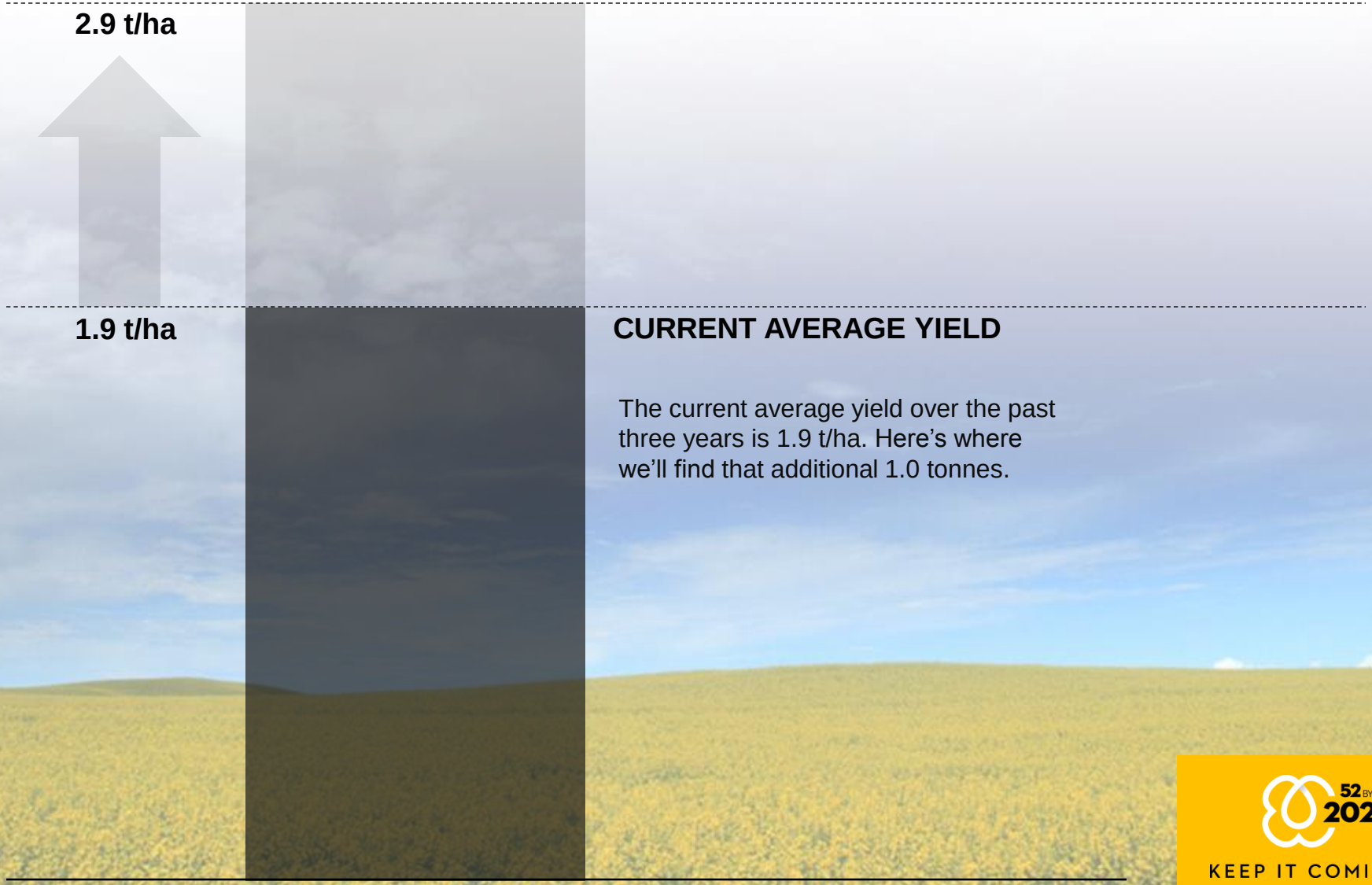
Major canola export markets



Export value of Canadian Canola



WHAT WILL IT TAKE TO GET TO 2.9 BY 2025?



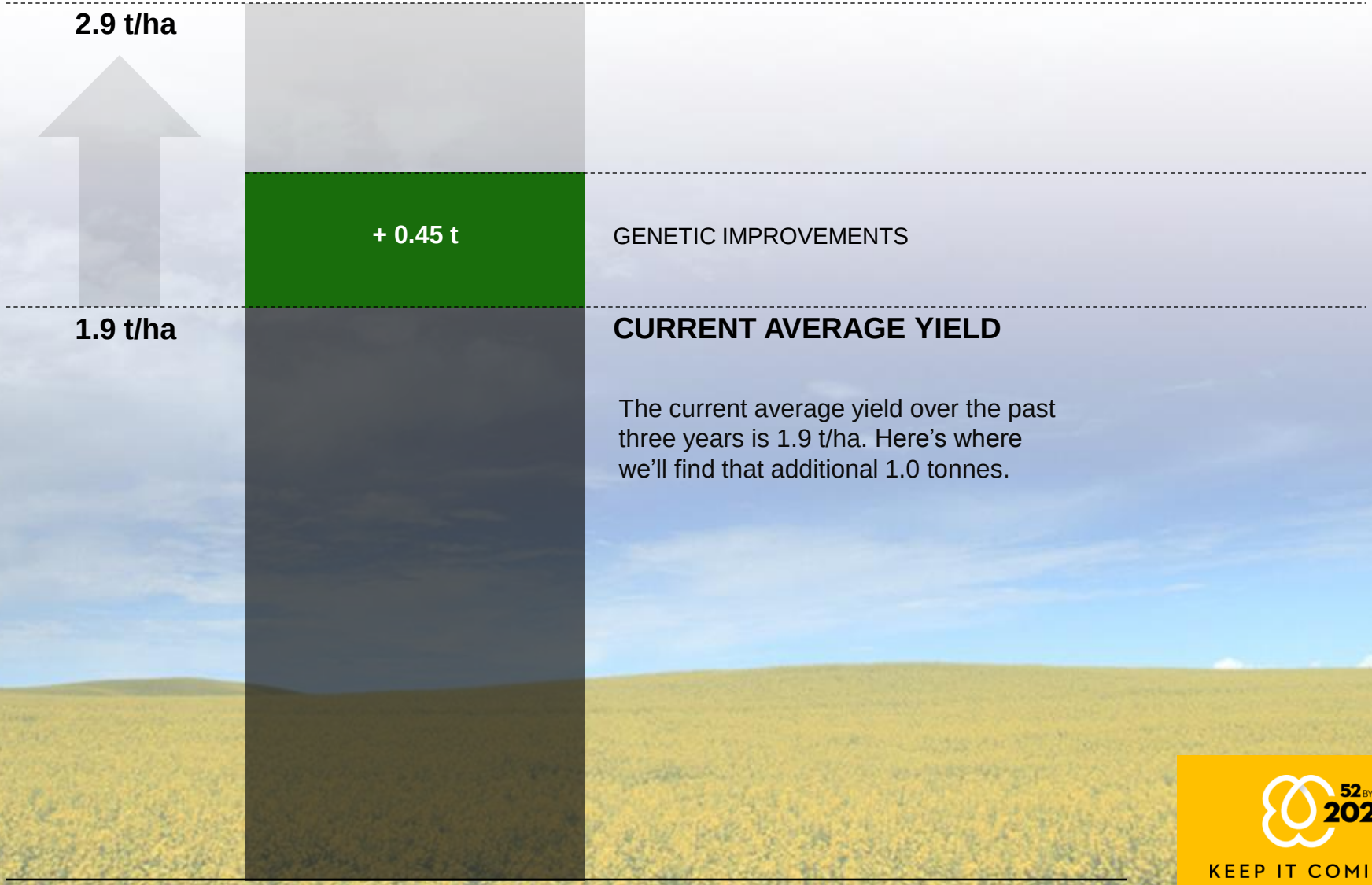
CURRENT AVERAGE YIELD

The current average yield over the past three years is 1.9 t/ha. Here's where we'll find that additional 1.0 tonnes.

52 BY 2025

KEEP IT COMING

WHAT WILL IT TAKE TO GET TO 2.9 BY 2025?



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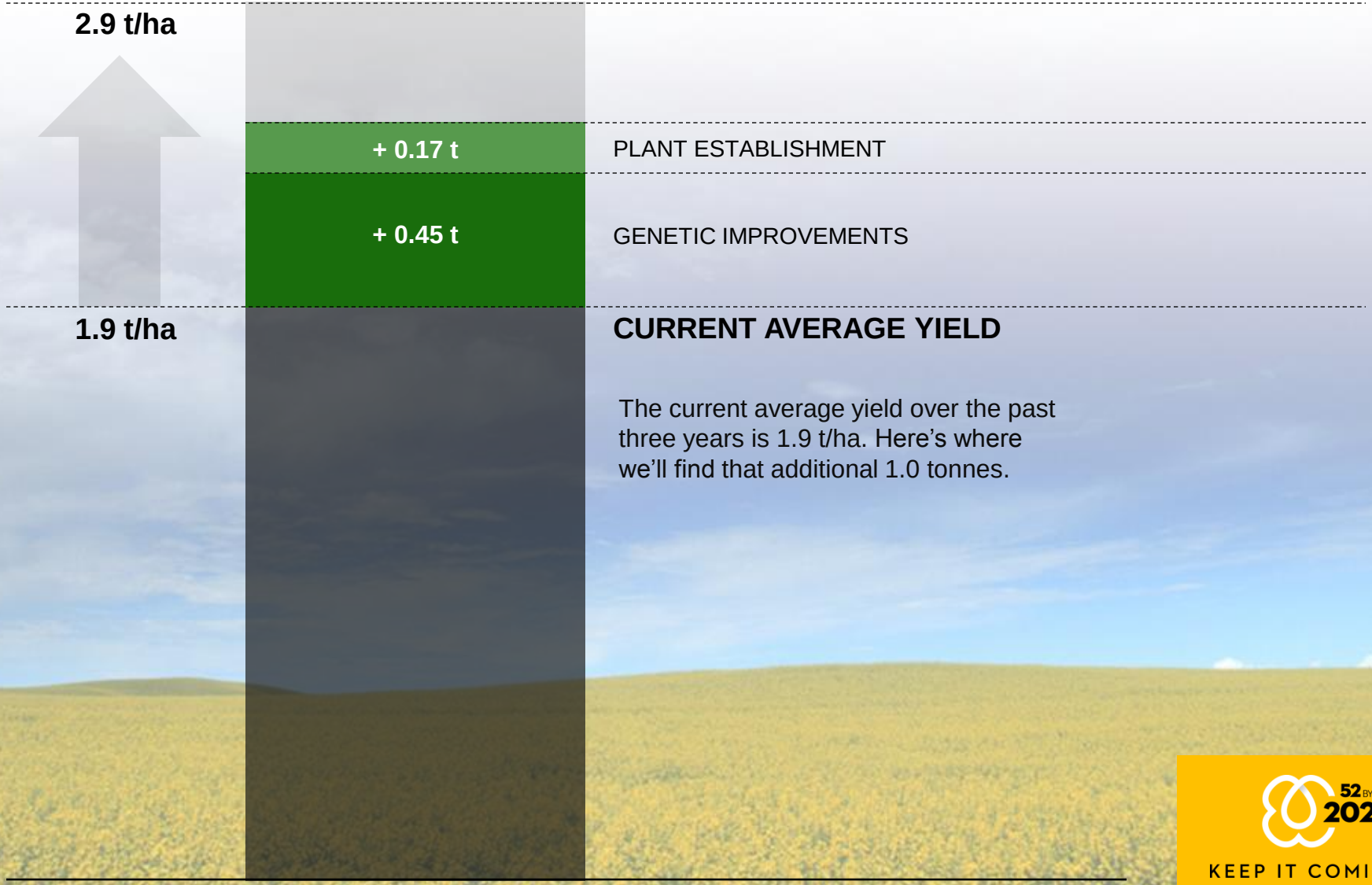

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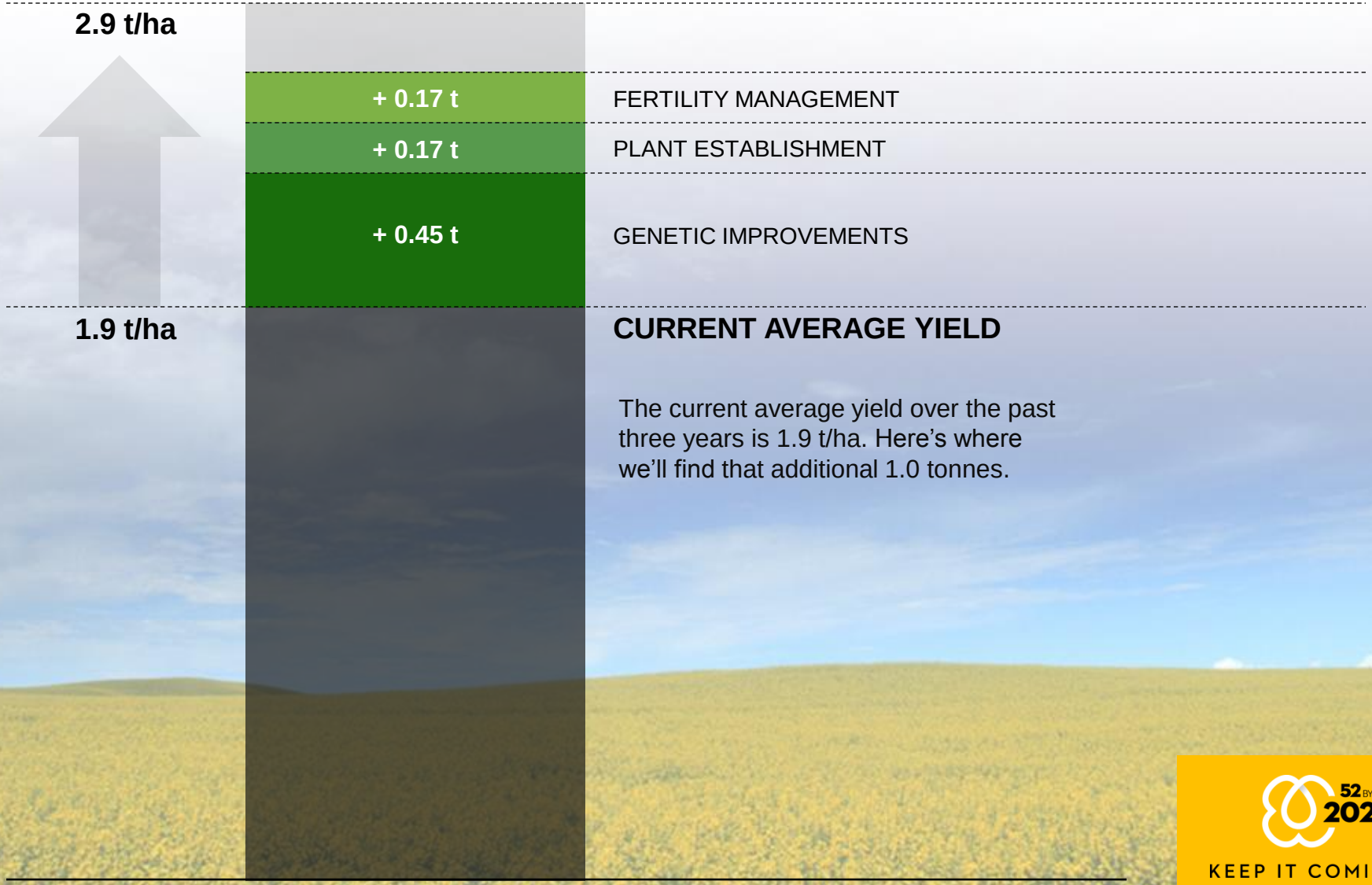

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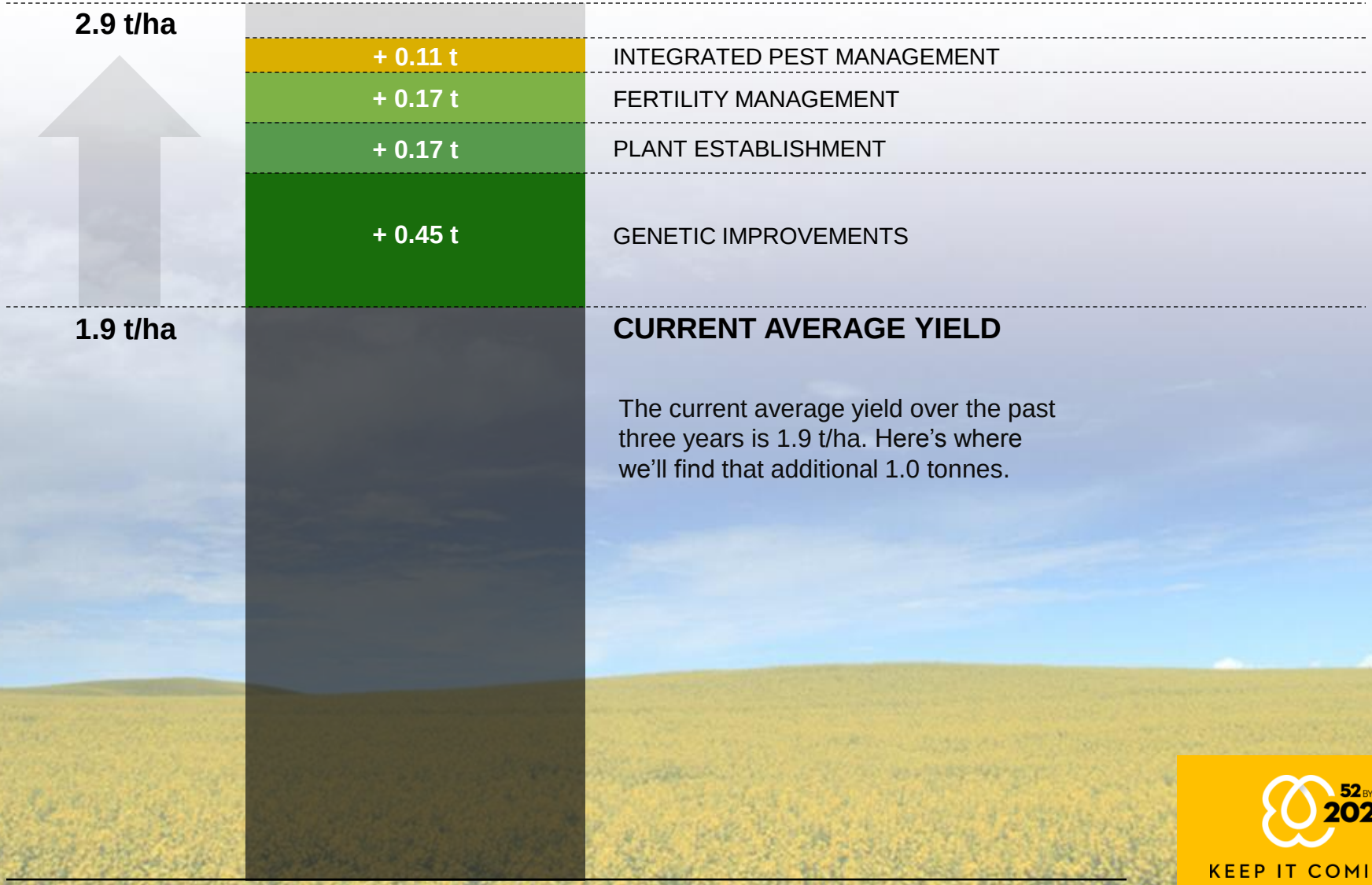

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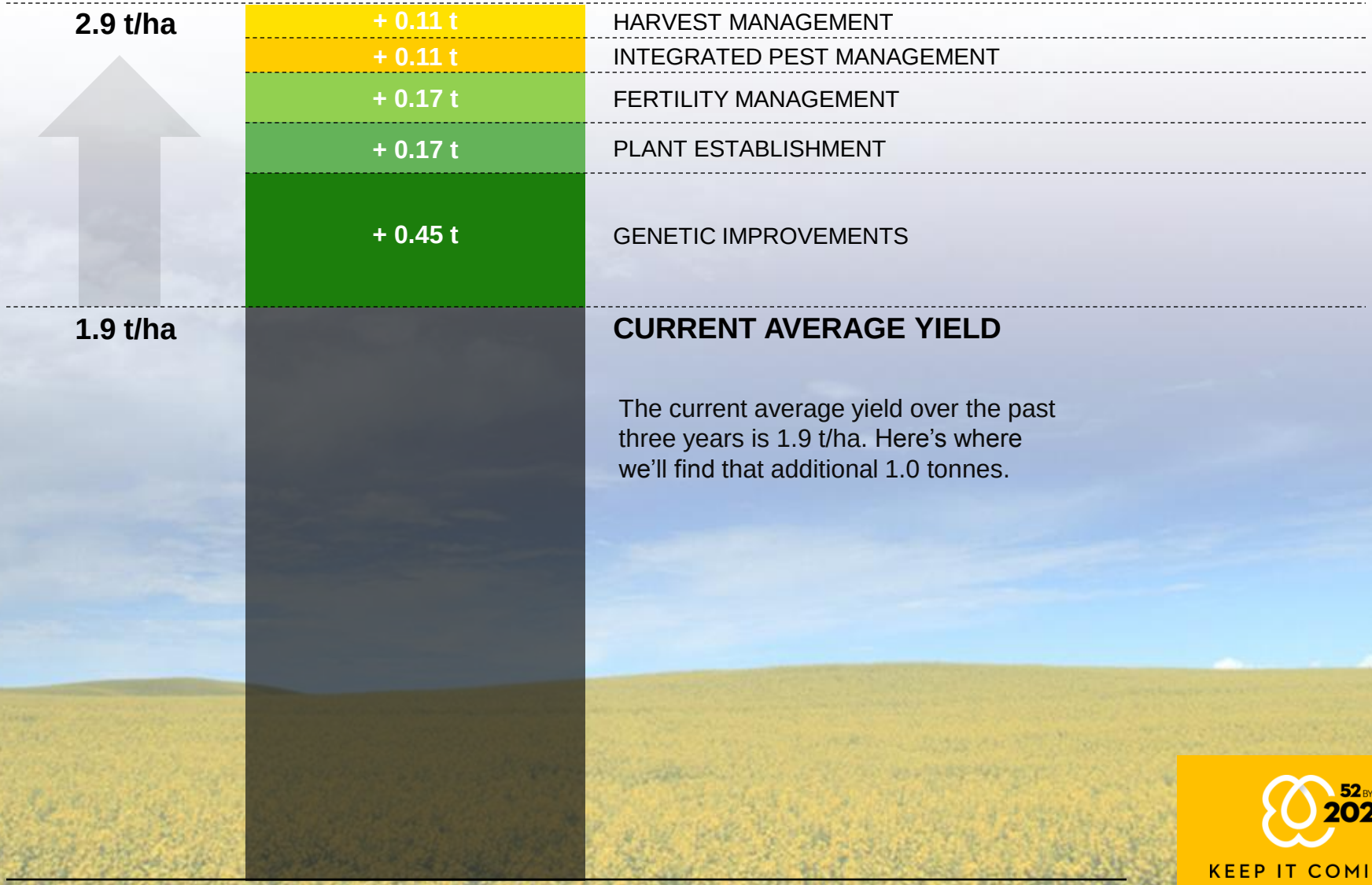

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52 BY 2025

KEEP IT COMING

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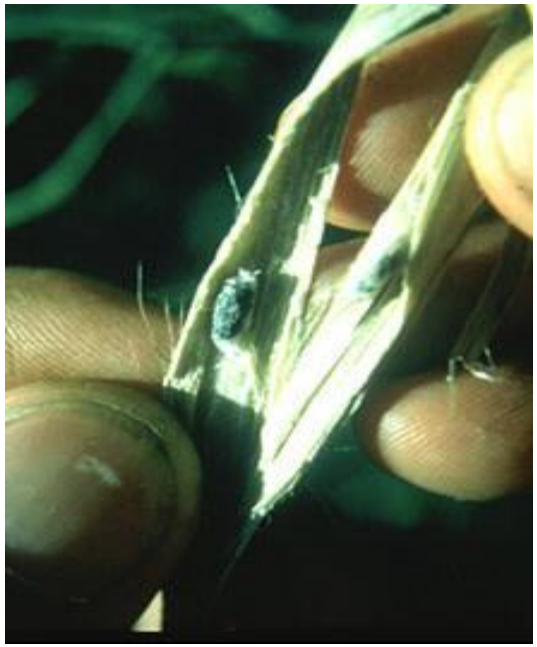
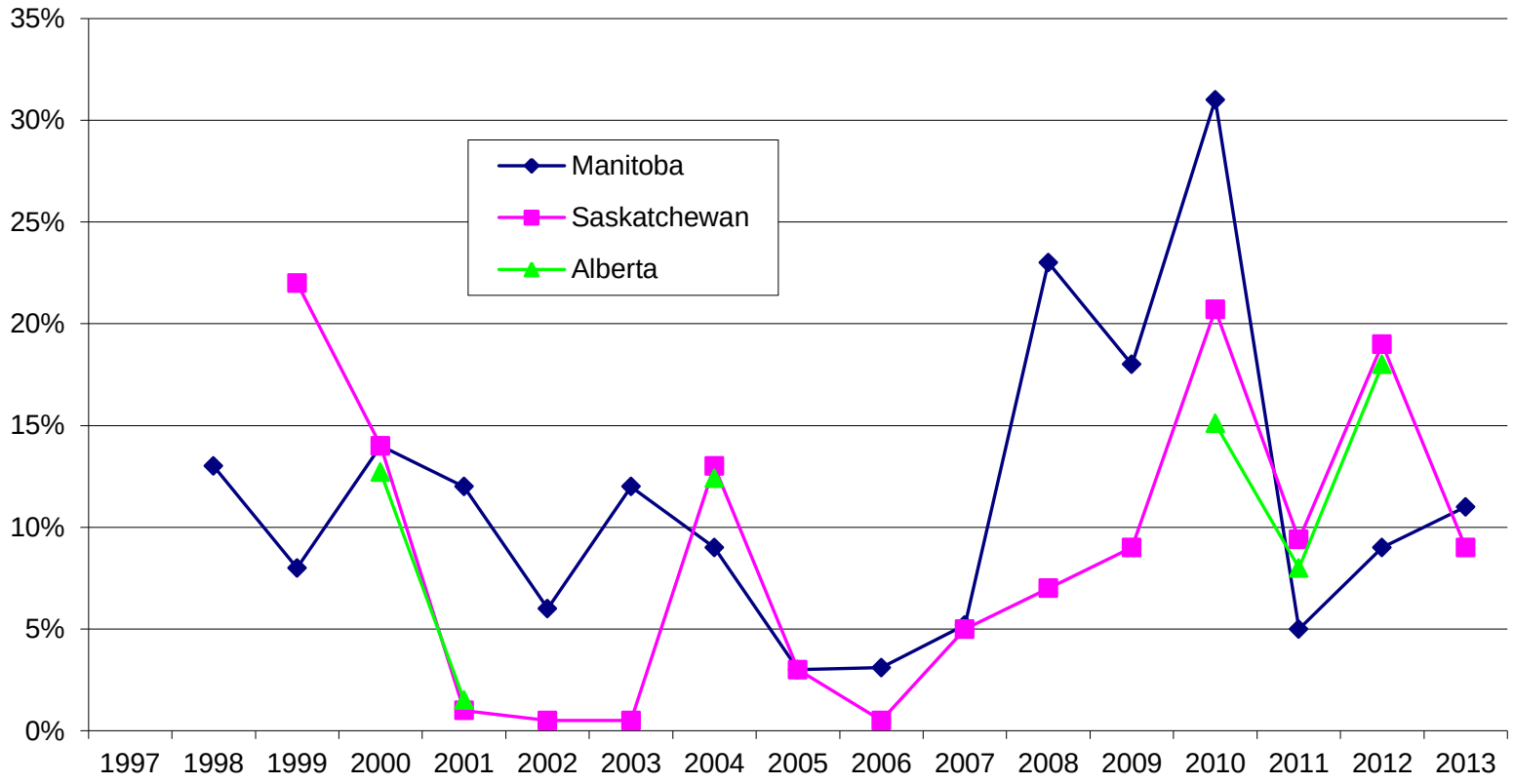
Sclerotinia Stem Rot

Sclerotinia Stem Rot

- Caused by the necrotophic fungus,*Sclerotinia sclerotiorum*
- It infects > 400 plant species
- It is found world-wide
- It is the most damaging canola disease in Canada



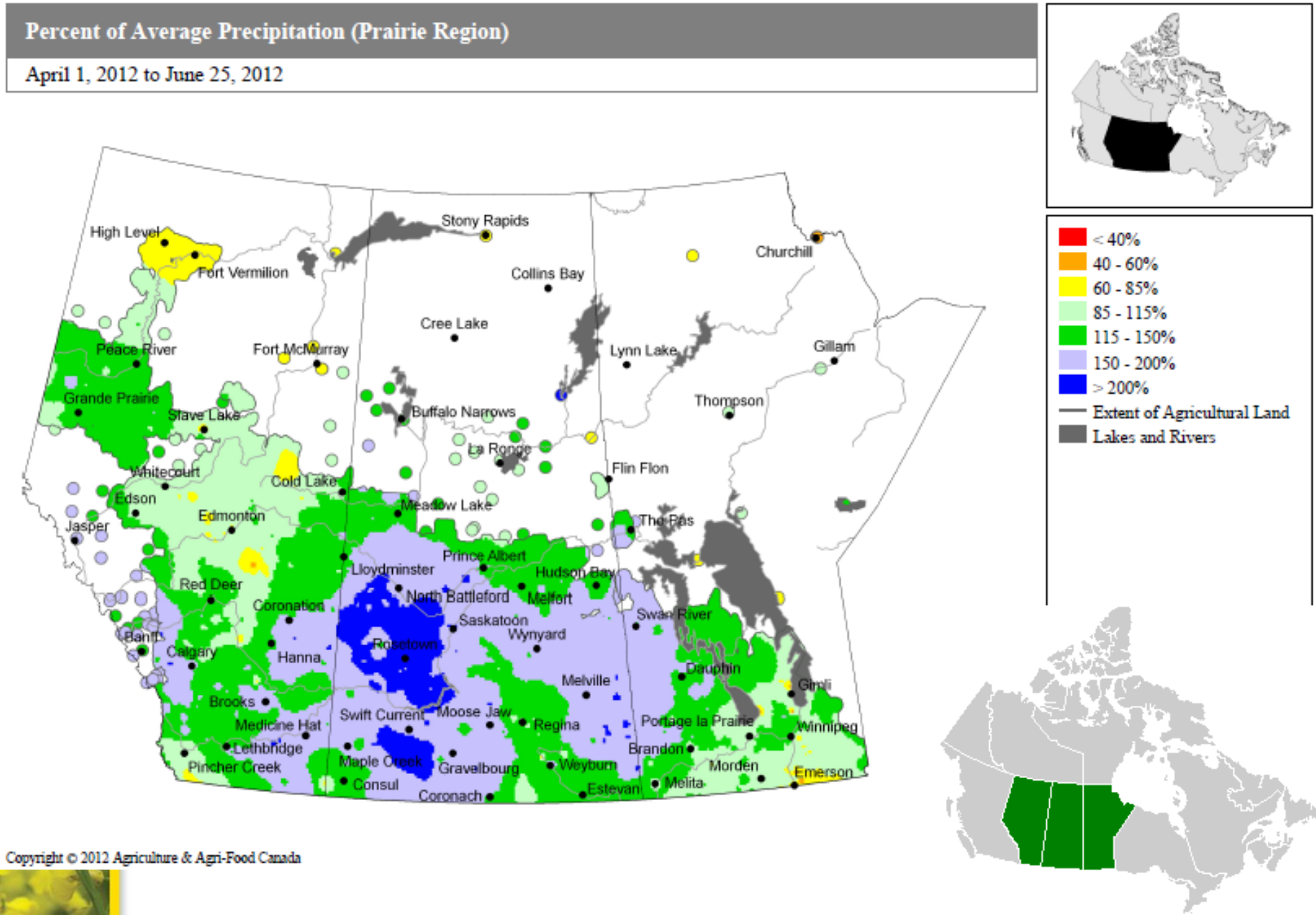
Sclerotinia stem rot Incidence in Western Canada



Sclerotinia Stem Rot

- Yield Loss
  - Estimated to be 5% annually in Canada
    - Ranges from 0% to 10% in some provinces
  - 20 - 50% yield loss annually in China

- 2012


Percent of Average Precipitation (Prairie Region)
April 1, 2012 to June 25, 2012
High Level
Fort Vermilion
Stony Rapids
Collins Bay
Churchill
Cree Lake
Peace River
Fort McMurray
Lynn Lake
Gillam
Grande Prairie
Buffalo Narrows
Thompson
Slave Lake
La Ronge
Flin Flon
Whitecourt
Cold Lake
Edson
Meadow Lake
Edmonton
The Pas
Jasper
Prince Albert
Lloydminster
Hudson Bay
Red Deer
North Battleford
Melfort
Coronation
Saskatoon
Swan River
Banff
Wynyard
Calgary
Rosetown
Hanna
Dauphin
Melville
Gimli
Brooks
Swift Current
Moose Jaw
Regina
Portage la Prairie
Winnipeg
Medicine Hat
Brandon
Lethbridge
Maple Creek
Gravelbourg
Weyburn
Morden
Pincher Creek
Consul
Estevan
Melita
Emerson
Coronach
< 40%
40 - 60%
60 - 85%
85 - 115%
115 - 150%
150 - 200%
> 200%
Extent of Agricultural Land
Lakes and Rivers
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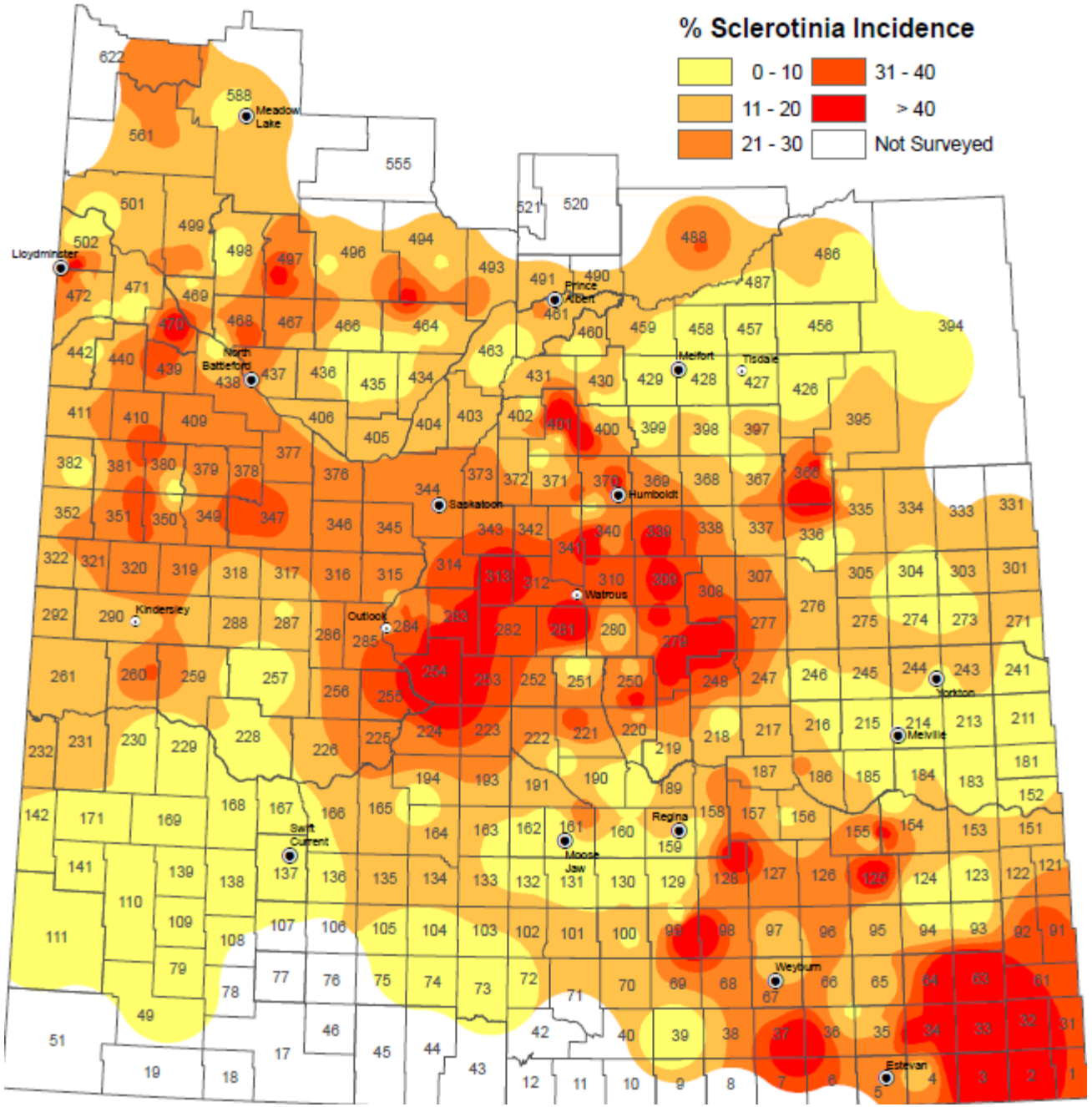
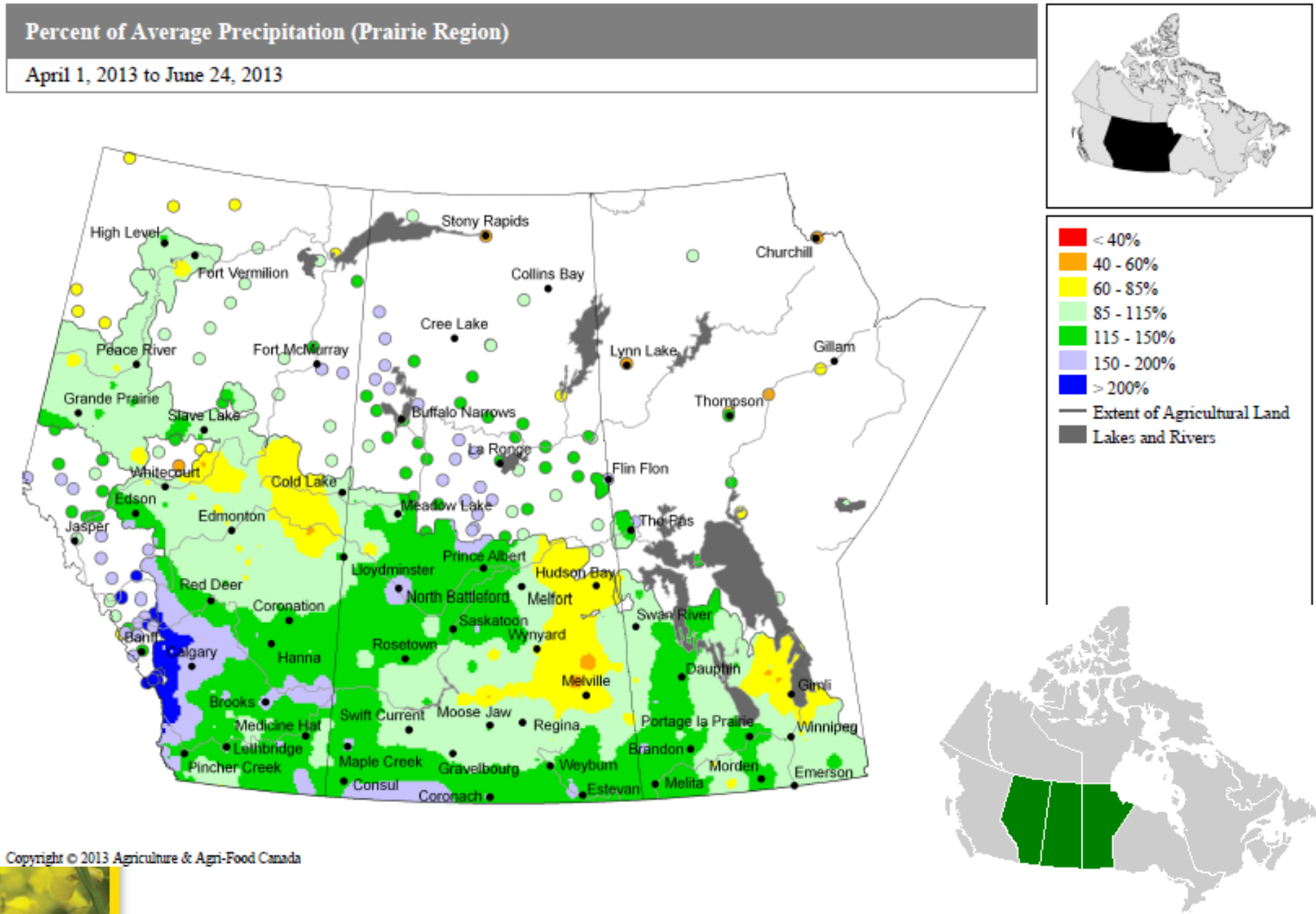
- Sclerotinia stem rot infection in 2012



- 2013



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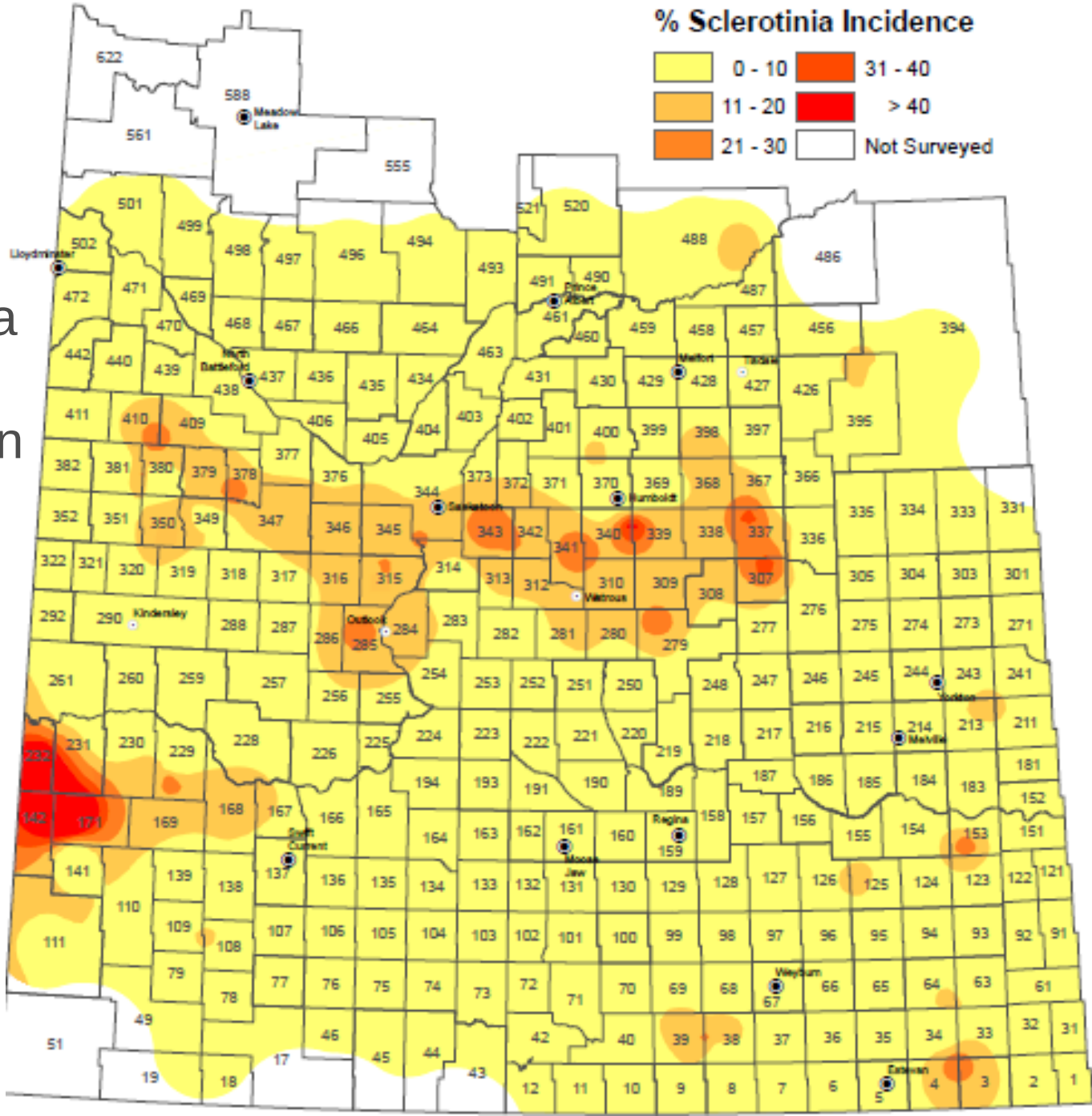
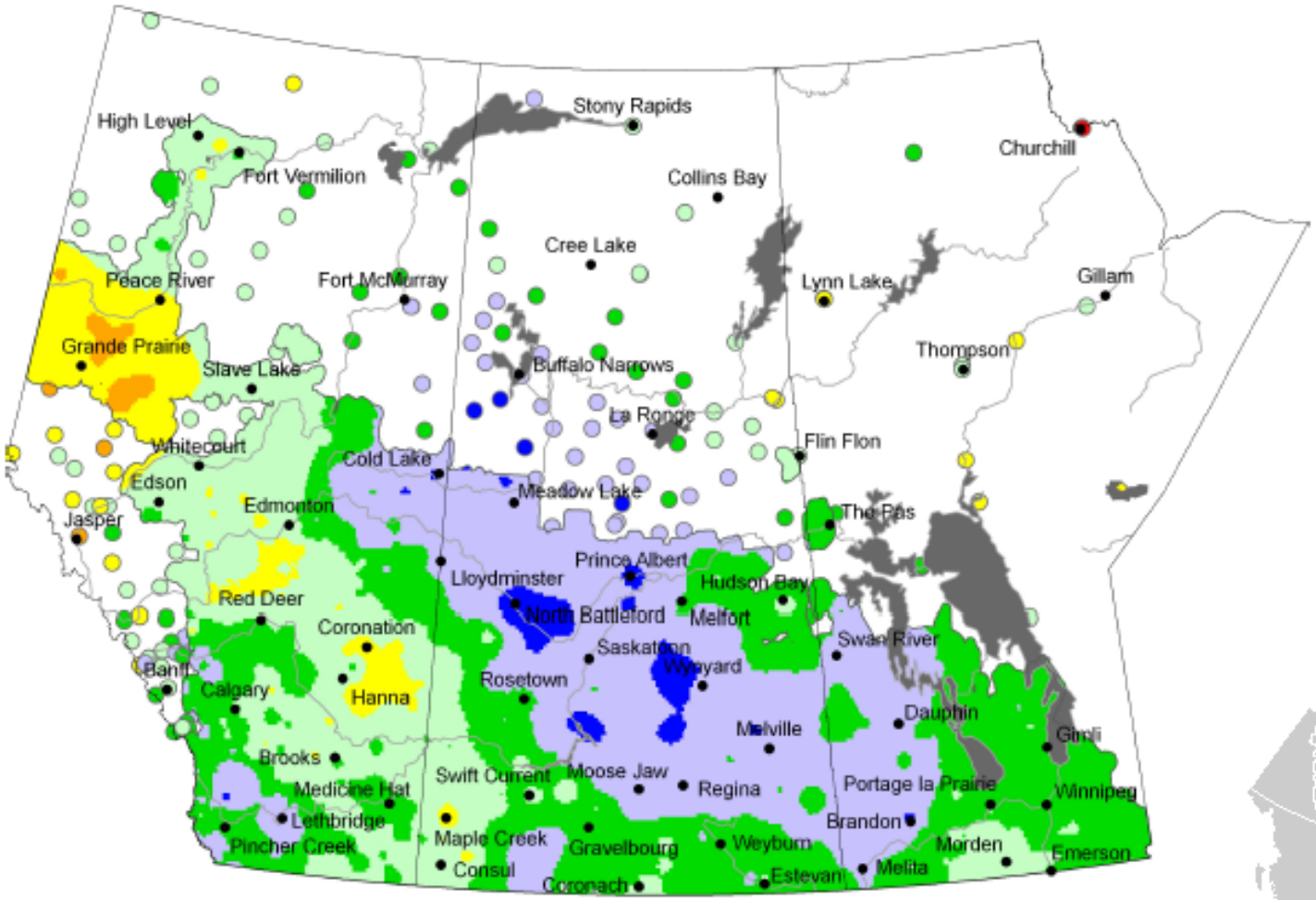
- Sclerotinia stem rot infection in 2013



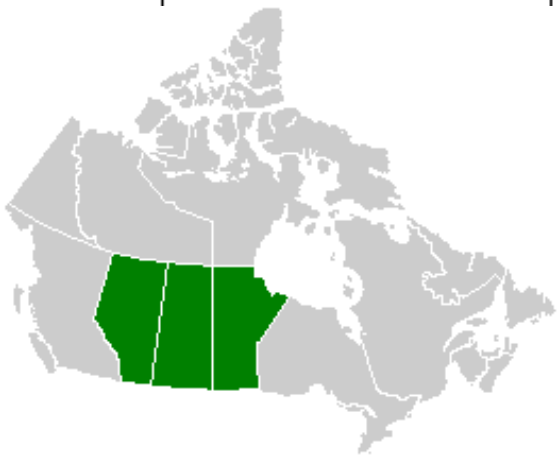
- 2014

Percent of Average Precipitation (Prairie Region)

April 1, 2014 to June 23, 2014



- < 40%
- 40 - 60%
- 60 - 85%
- 85 - 115%
- 115 - 150%
- 150 - 200%
- > 200%
- Extent of Agricultural Land
- Lakes and Rivers



- 2014?

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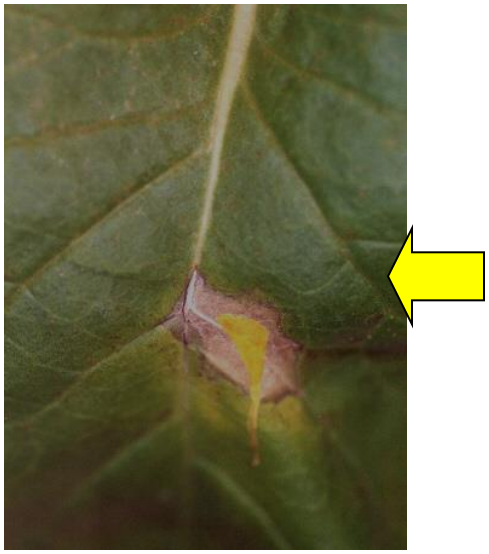
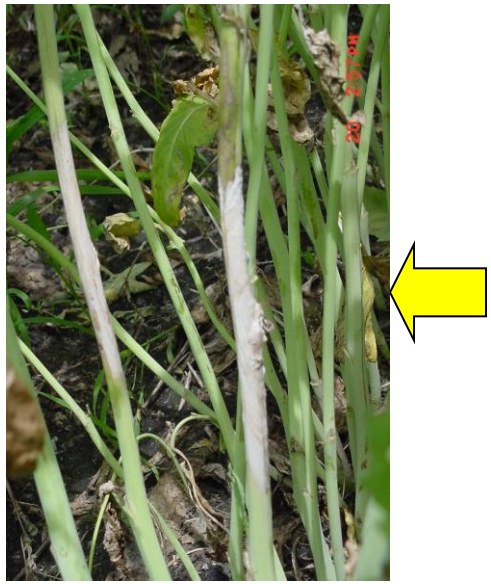
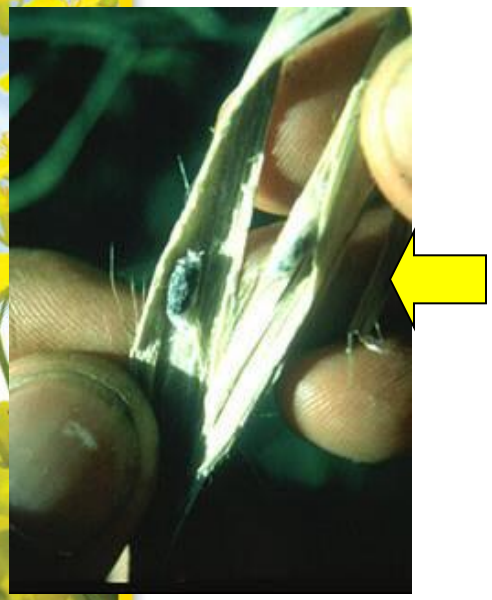
Sclerotinia Stem Rot Disease Cycle







Factors that Contribute to Sclerotinia Stem Rot

1. Amount and availability of moisture
2. Correct temperature
3. Conducive microenvironment
4. Ascospores produced at early flowering

How can we control Sclerotinia Stem Rot?

- Tolerance (“Resistance”)
- Cultural/agronomic control
- Biological
- Fungicide

Commercial Resistance/Tolerance

DuPont/Pioneer Seeds

- 45S52
- 45S53
- 45S54
- D3154S

- Claim 65% reduction in disease

Bayer/InVigor Seeds

- L160S

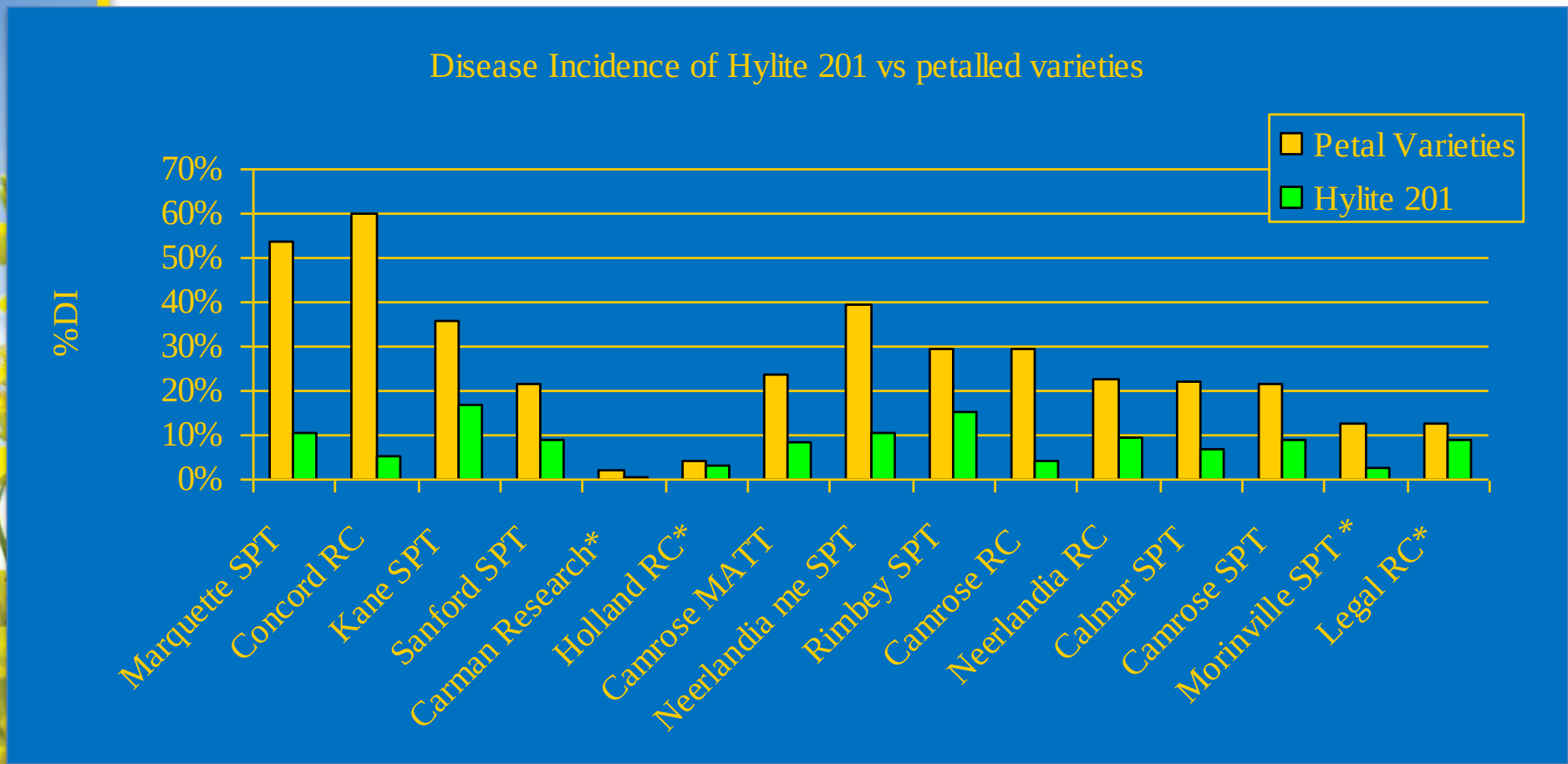
- No reduction claims.

Is there better resistance?

- Apetalous canola
  - No petals

Is there better resistance?

- Apetalous canola
  - No petals



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Dissecting quantitative resistance to *Sclerotinia sclerotiorum* in Asian *Brassica napus* germplasm

Lone Buchwaldt
Dwayne Hegedus
Derek Lydiate
Isobel Parkin
Roger Rimmer

<u>Post Docs.</u>
Fuyou Fu
Harsh Garg
Sanjaya Gyawali
Jianwei Zhao

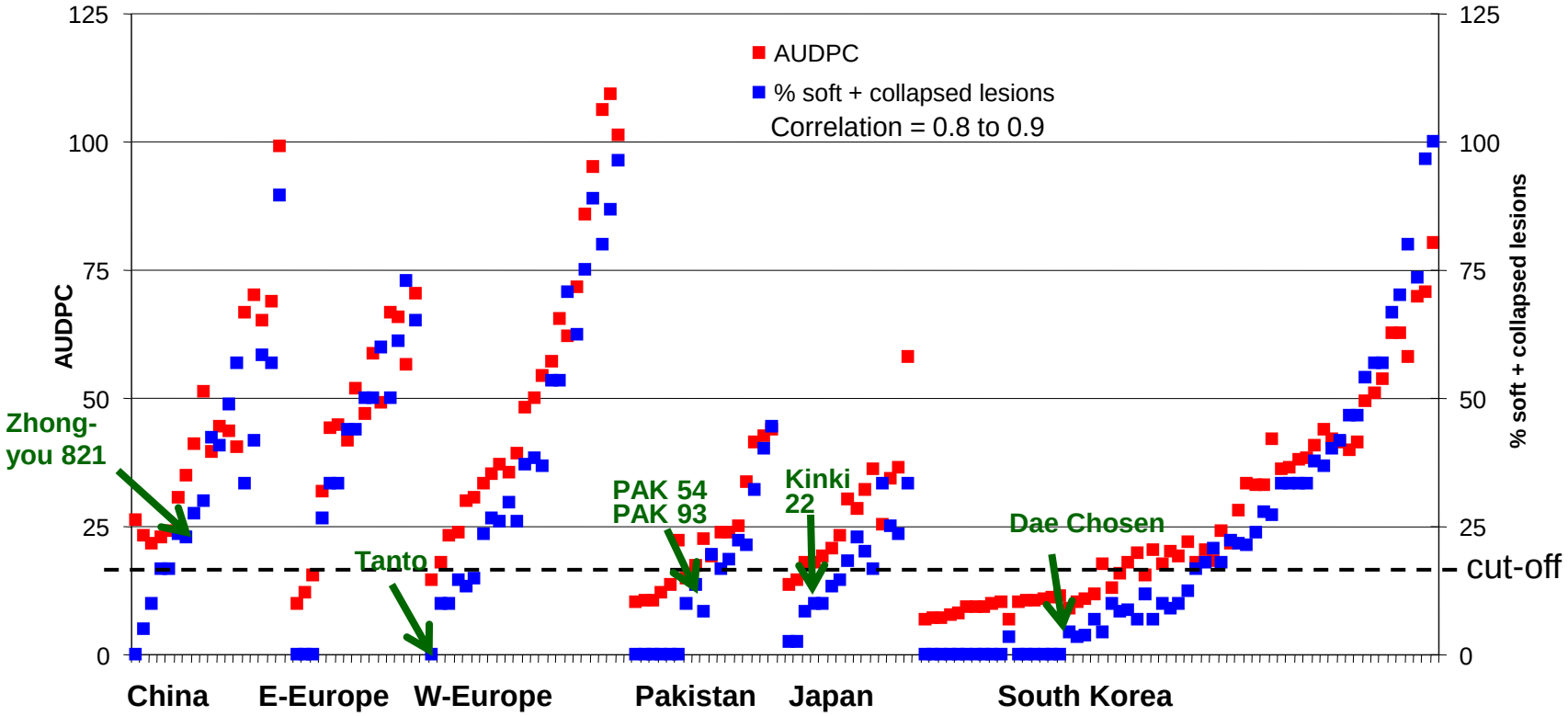
Saskatoon Research Centre
Saskatchewan

Canada

Sources of resistance in a world collection of *B. napus*

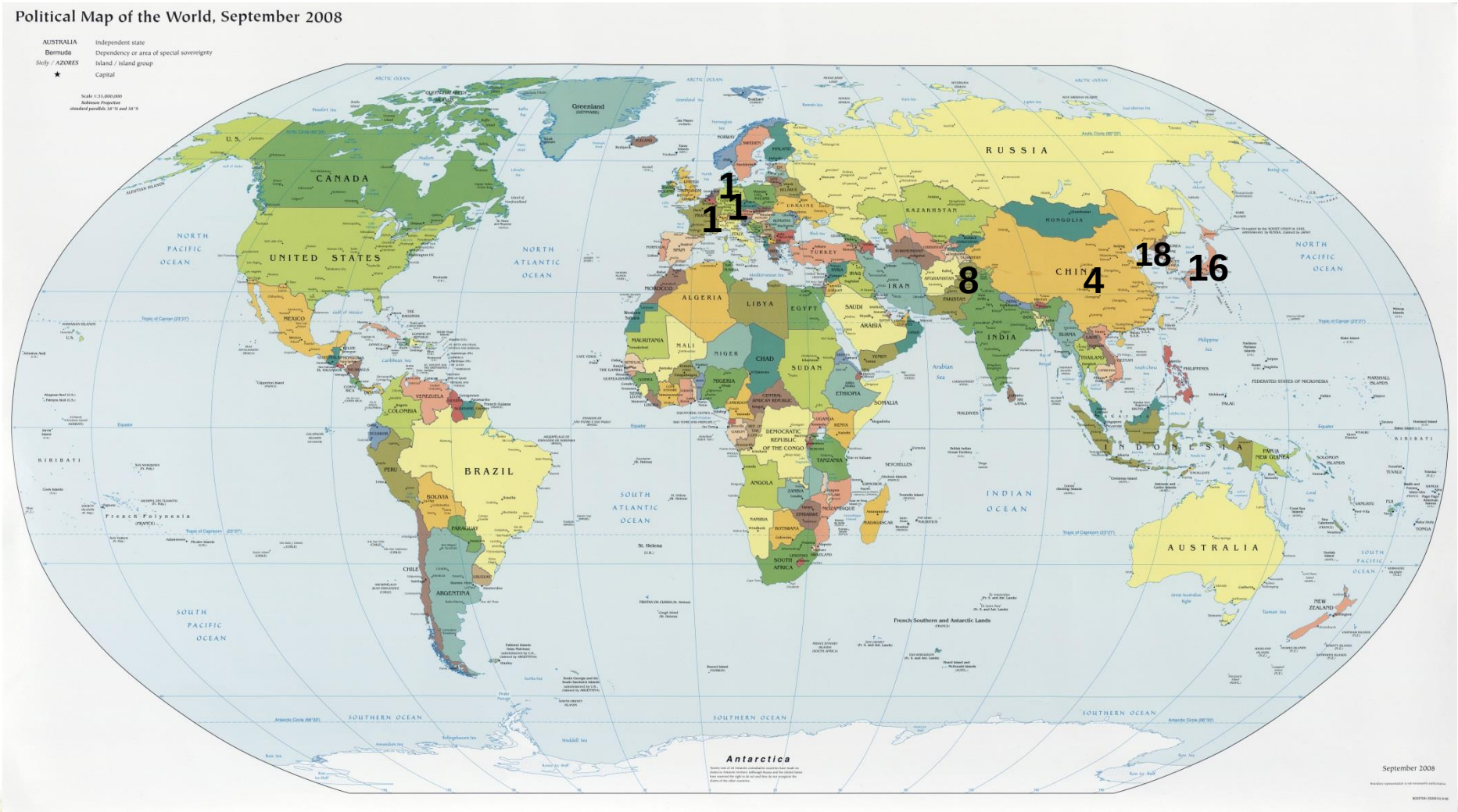
Method

400 *B. napus* landraces and cultivars held at Plant Gene Resources of Canada (Saskatoon, SK) were phenotyped with a single *S. sclerotiorum* isolate #321.



Landraces are mixtures of genotypes with varying amount of heterozygosity they segregated for sclerotinia resistance, days to flower and other morphological traits. One or two cycles of inoculation and single plant selected was undertaken to reduce variability in disease reaction

Number of resistant *B.* napus accessions by country



SSR markers associated with resistance and susceptibility

SSR with R^2 = 7- 26% variability explained

25 SSR associated with resistance

17 SSR associated with susceptibility

SSR markers associated with resistance and susceptibility are similar in lines from South Korea, Japan and China while lines from Pakistan and Europe have different SSR fingerprint

Research results to date

The *S. sclerotinia* population in western Canada is genetically diverse as demonstrated both in genetic dissimilarity and MCG studies – “ring species” observed

Isolates from canola vary in aggressiveness

Several sources of resistance were identified from Asia and a few from Europe

Asian lines share several resistance QRL as demonstrated by association mapping while lines from Pakistan and Europe may have different QRL

QRL conferring sclerotinia resistance were mapped in bi-parental populations derived from the Chinese cultivar Zhongyou 821 and two lines from Pakistan, PAK54 and PAK93

Genes encoding O-methyl transferase contributes to sclerotinia resistance

Research in progress

Mapping of QTL in lines from South Korea, Japan and Europe

Genotyping undertaken with SNP arrays

Second gene expression study using Asian lines

Continue dissection of more defense genes underlying each QRL

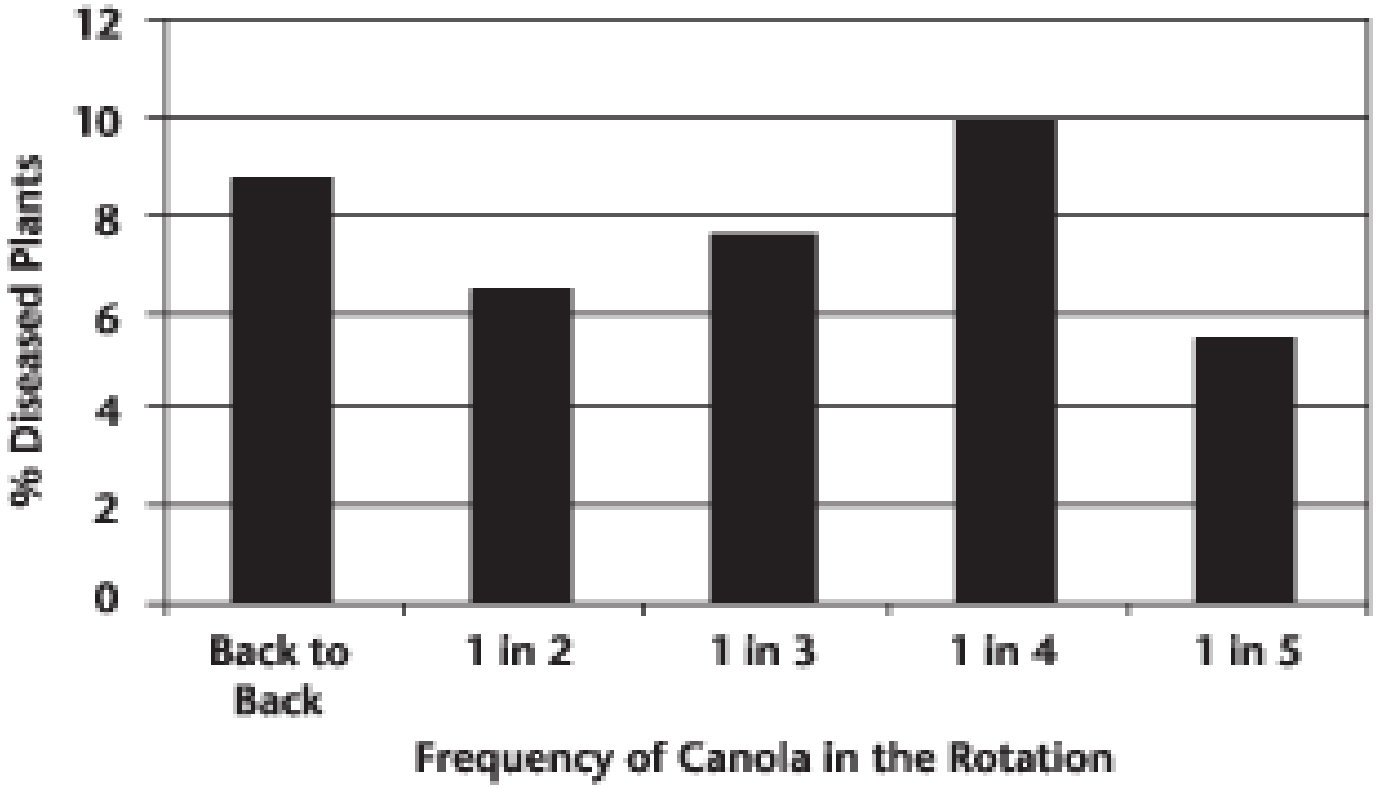
Transfer of sclerotinia QTL into elite spring canola breeding line N99-508 using a combination of back crossing, DH steps and intercrossing of sister lines in collaboration with AAFC's canola breeder Sally Vail

Lodging susceptibility

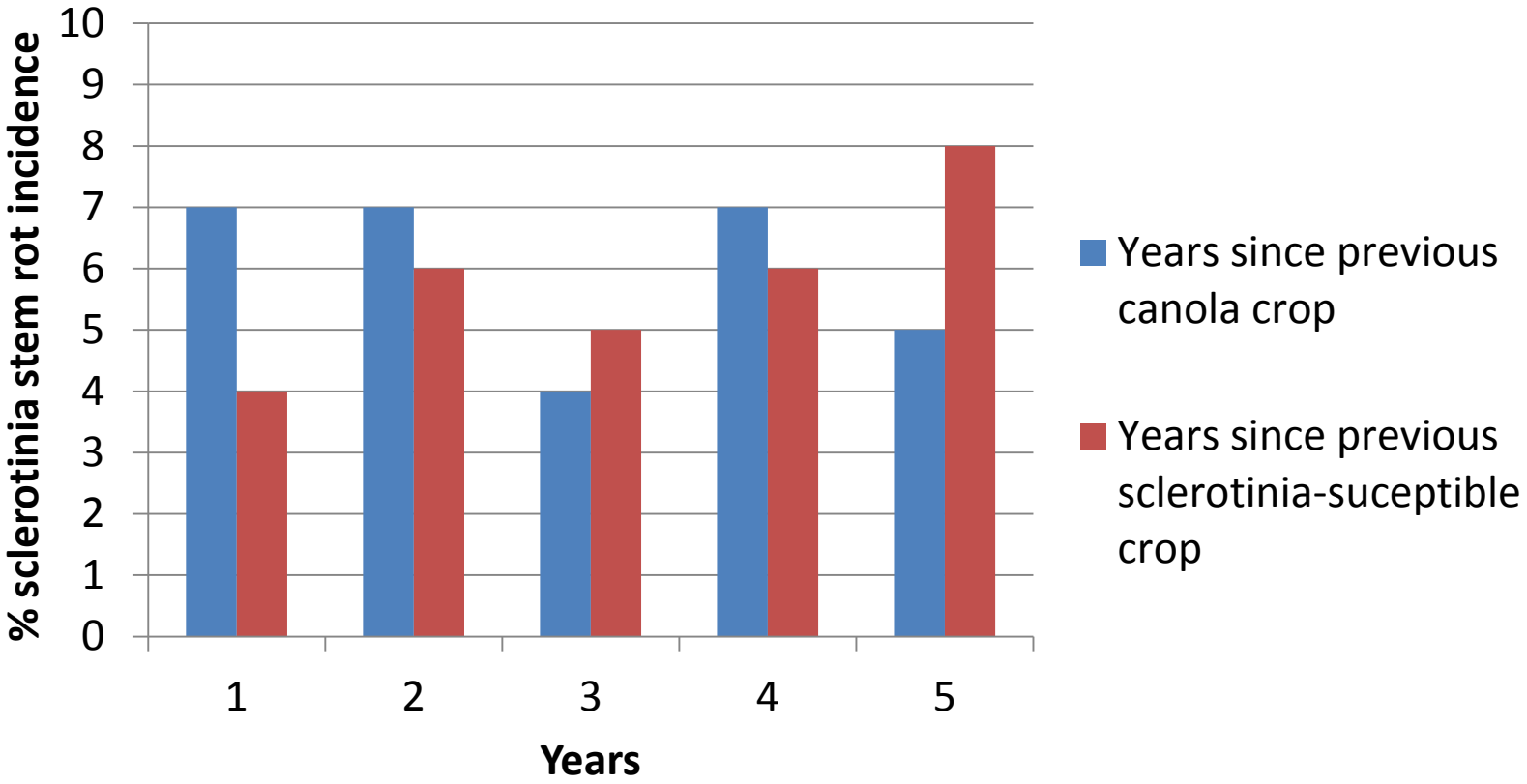
- Increases in lodging causes increases in sclerotinia stem rot

Cultural Control of Sclerotinia Stem Rot

- Crop rotations are not an effective management strategy



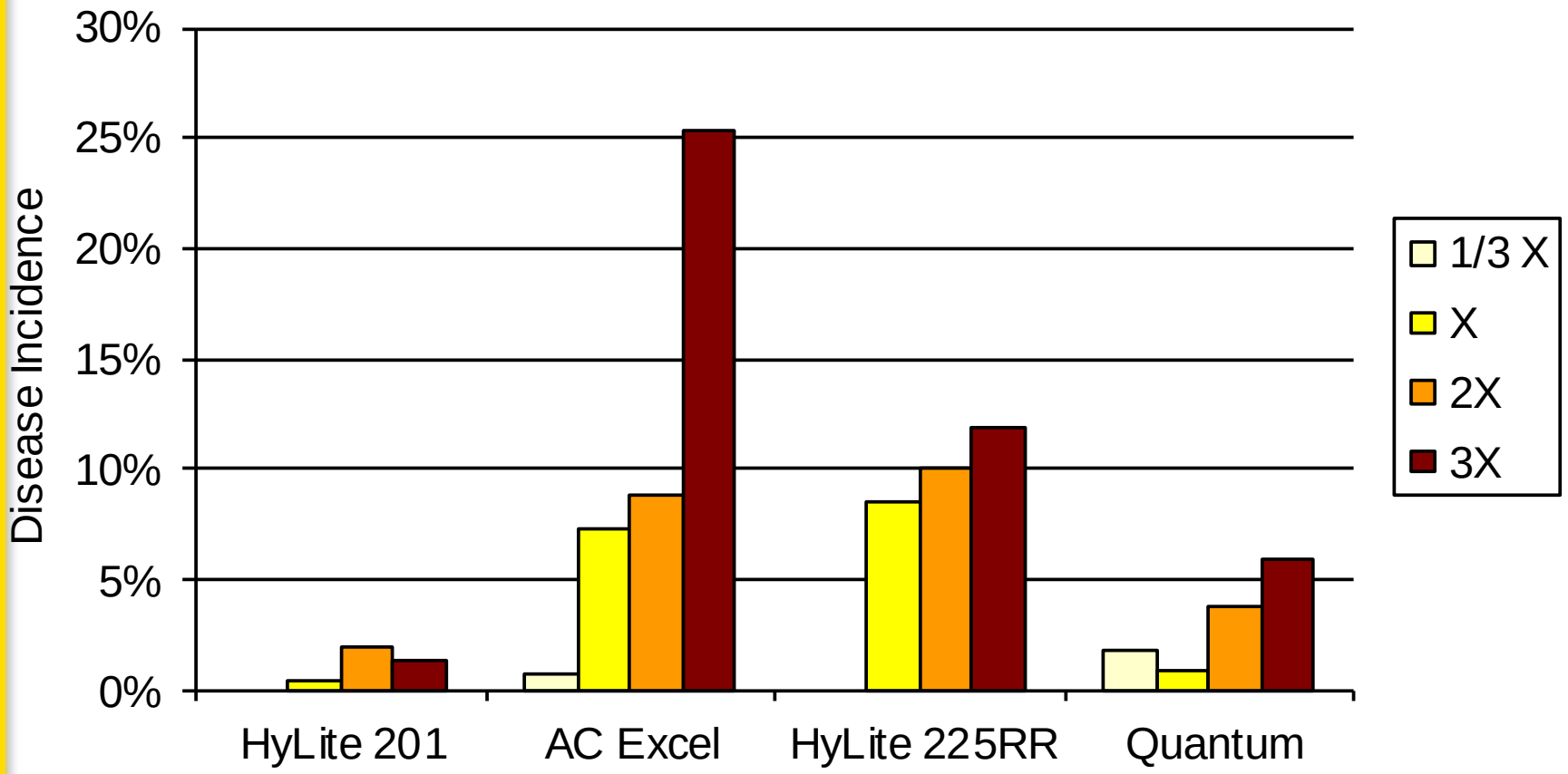
Effect of Rotation on sclerotinia stem rot incidence



Source: Report on 1997 Western Canada Canola Disease Survey, R.A.A. Morrall et al.

Canopy modification?

- Seeding rate?



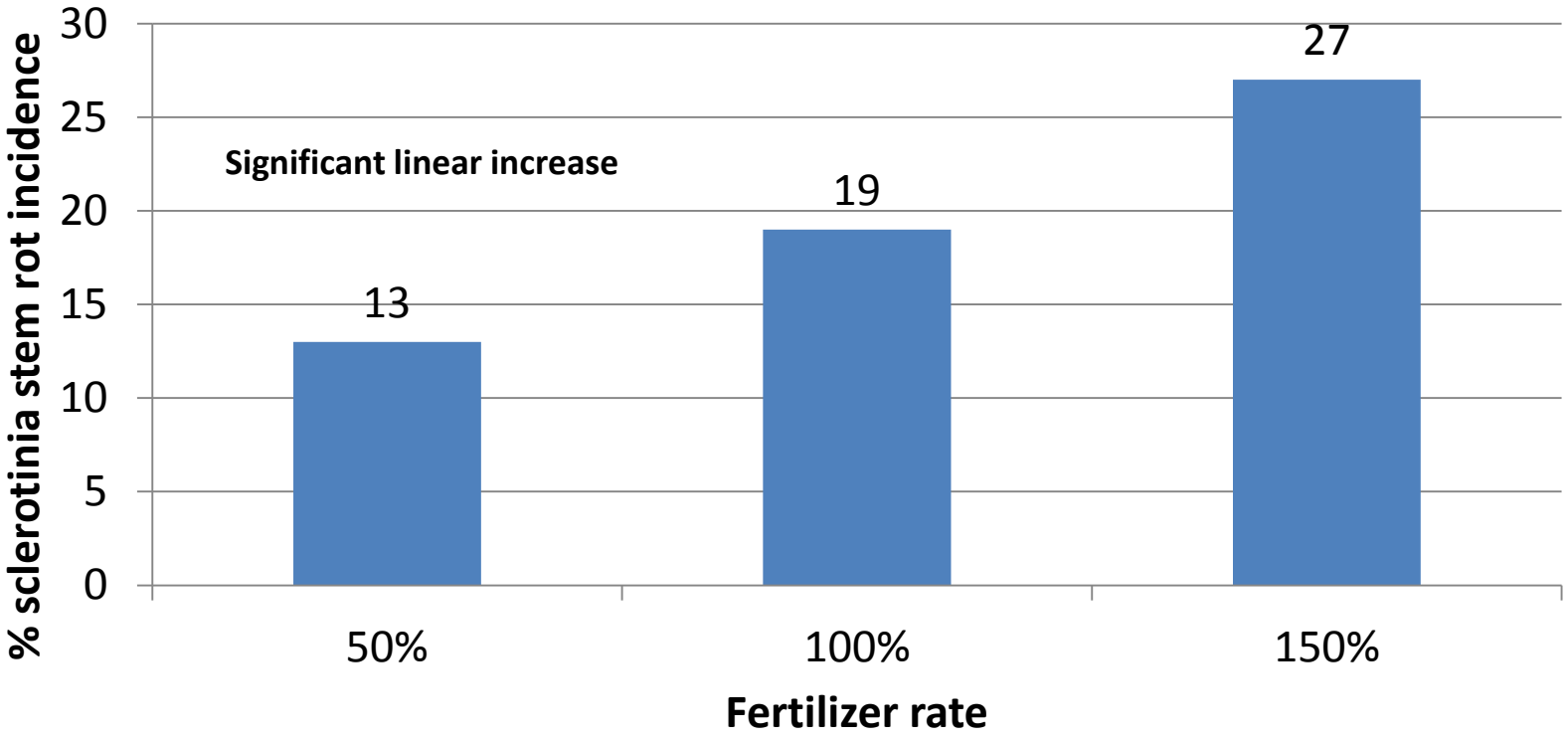
Jurke & Fernando, 2006

Other cultural control options

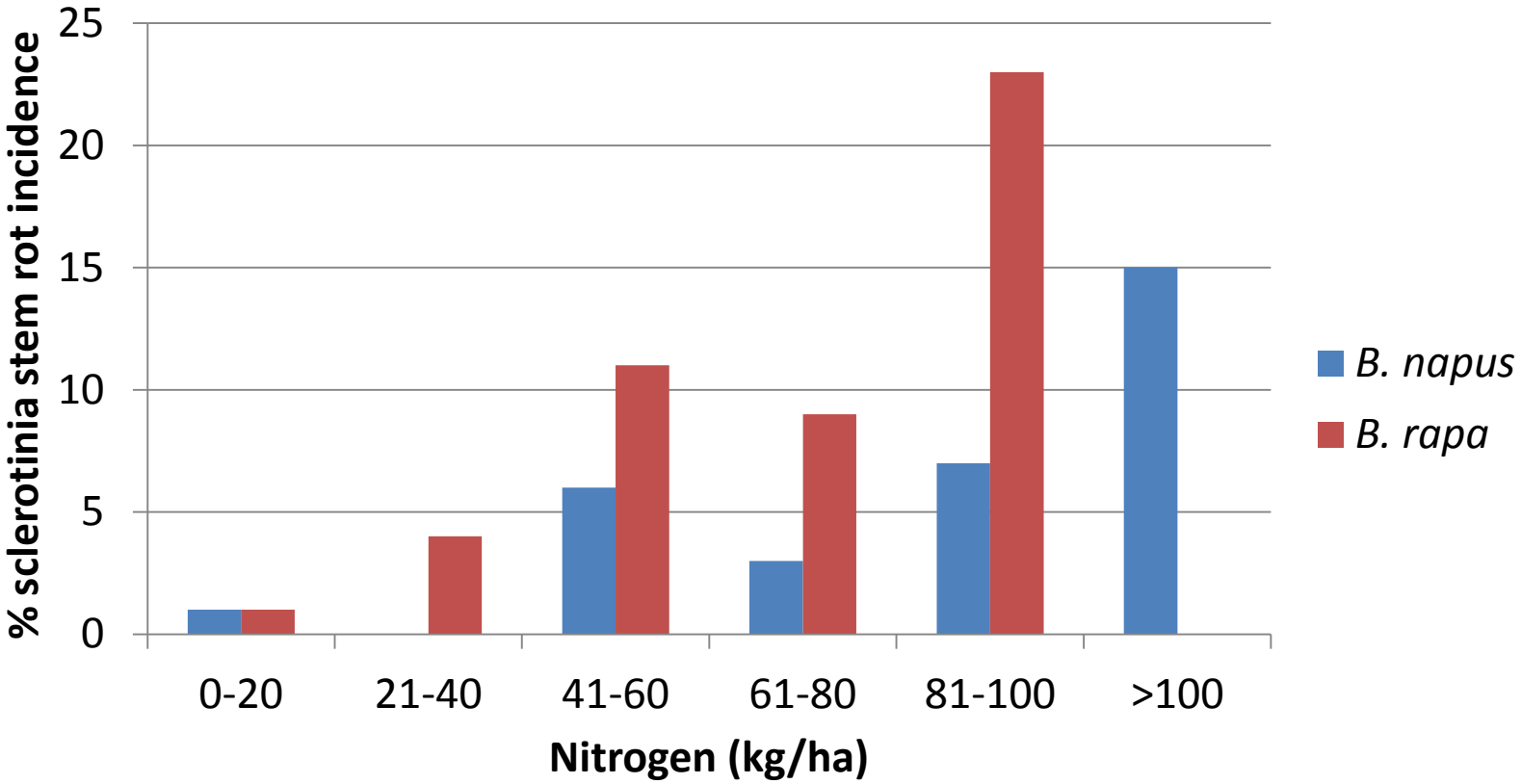
- Row width
- Row orientation
- Irrigation
- Fertility
- Tillage

- Factors that reduce canola yield will reduce sclerotinia stem rot
  - Wide rows
  - No irrigation
  - Low fertility
  - Increased tillage

Fertility rate and sclerotinia stem rot incidence



Effect of Nitrogen Fertilizer on sclerotinia stem rot incidence



Source: Report on 1997 Western Canada Canola Disease Survey, R.A.A. Morrall et al.

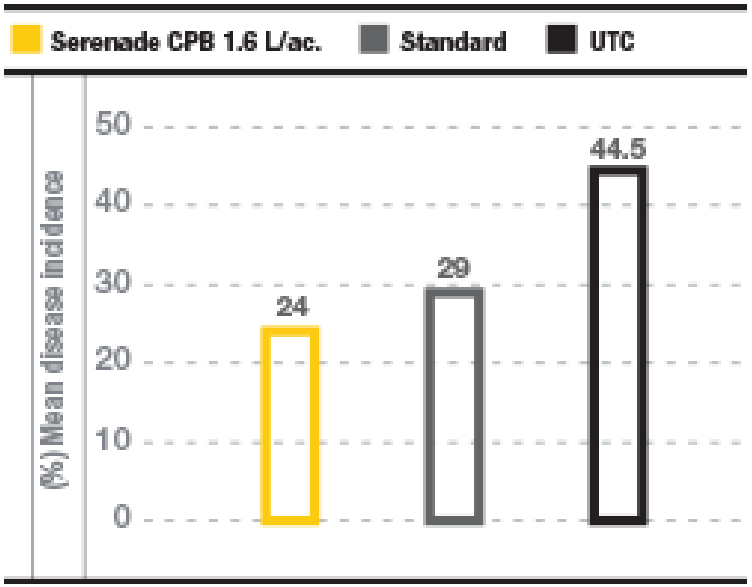
Biological Control

- Contans WG
  - A mycoparasite that feeds on sclerotia – *Coniothyrium minitans*

Source: UAP Canada Inc.

Biological Control

- Serenade
  - a broad-spectrum, biological foliar fungicide – *Bacillus subtilis*



Source: 16 sclerotinia control studies in Canada, 2008-2009.

Source: Bayer CropScience.

Biological Control

- PA23

Fungicides

- Fungicides are still the most common and most popular form of sclerotinia stem rot control in Canada
- Estimated that 25 to 30% of acres are sprayed with fungicides each year.
- The difficulty with using fungicides is determining whether the risk of disease outbreaks warrants the use of a fungicide, which is costly.

Fungicides + Biologicals

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Product	Active	Fungicide Group	Stage	Rate/acre	Water/acre	Split Application
Acapela	Picoxystrobin	11	20 – 50%	350 – 490 ml	4.5 - 10 gal	Yes
Astound	Cyprodinil + Fludioxonil	9 + 12	20 - 30%	310 – 390 g	20 gal	No
Lance	Boscalid	7	20 – 50%	142 g	9 gal	Yes
Overall	Iprodione	2	20 – 50%	850 – 1250 ml	9 gal	Yes
Proline	Prothioconazole	3	20 – 50%	128 - 149 ml	9 gal	No
Quadris	Azoxystrobin	11	Prior to 30%	280 - 400 ml	9 gal	No
Quash	Metconazole	3	20 – 50%	113 g	20 gal	Yes
Rovral Flo	Iprodione	2	20 – 50%	850 – 1250 ml	9 gal	Yes
Vertisan	Penthiopyrad	7	20 – 50%	500 – 600 ml	10 gal	Yes
Serenade	*Bacillus subtilis*	biological	20 – 30%	1.0 – 4.0 l	Ensure coverage	Yes
Contans	*Coniothyrium minitans*	Biological	Pre-crop	0.4 – 1.6 kg	n/a	n/a

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When to spray a fungicide?

- 20% to 50% bloom stage to control Sclerotinia stem rot is the common recommendation.
- Canadian canola growers have difficulty in determining the correct flower stage.

When to spray?

- 20% bloom stage
  - Usually about 4-6 days after start of flowering.
  - Approx. 15 flowers open on main stem.
  - No petals dropped yet.
  - Earliest time to consider spray application

Images courtesy of Bayer CropScience

When to spray?

- 30% bloom stage
  - Usually about 6-8 days after start of flowering.
  - Approx. 18-20 flowers open on main stem. Generally the maximum number of flowers open on main stem.
  - Little to no petals dropped yet.
  - no pod formation yet.
  - Ideal time to for spray application

Images courtesy of Bayer CropScience

When to spray?

- 50% bloom stage
  - Usually about 10 -14 days after start of flowering.
  - Crop at peak yellow
  - Approx. 20 flowers open on main stem.
  - Lateral branches have numerous petals open
  - Some petals have dropped already and pod formation evident on main stem.
  - Correct time for second application in a split application program.

Images courtesy of Bayer CropScience

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How do we optimise control?

- Staging
- Rates
- Coverage
- Right product

Risks of fungicide use

- Cost of application
  - Difficult to determine if the risk of disease is present
- Risk of fungicide resistance developing in *S. sclerotiorum*
  - Groups 11 and 2 highest risk
  - Groups 3 and 7 medium risk
  - Groups 9 and 12 medium to low risk

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How do we know if we should spray?

Wet early June

+

High Yielding Crop

+

Wet pants at onset of flower

SPRAY

Sclerotinia Stem Rot Checklist

(For each risk factor, circle the risk points that apply to your field).

RISK FACTOR	POSSIBLE ANSWERS	RISK POINTS
NUMBER OF YEARS SINCE LAST CANOLA CROP	More than six years	0
	Three to six years	5
	One to two years	10
DISEASE INCIDENCE IN LAST HOST CROP	None	0
	Low (1 to 10%)	5
	Moderate (11 to 30%)	10
	High (31 to 100%)	15
CROP DENSITY	Low	0
	Normal	5
	High	10
RAIN IN THE LAST TWO WEEKS	Less than 10 mm (0.4")	0
	10 to 30 mm (0.4 to 1.2")	5
	More than 30 mm (1.2")	10
WEATHER FORECAST	High pressure	0
	Variable	10
	Low pressure	15
REGIONAL RISK FOR APOTHECIA DEVELOPMENT	None found	0
	Low numbers	10
	High numbers	15

TOTAL RISK POINTS FOR ALL RISK FACTORS =


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Overview of Research
Current Research
Research Project Reports
Research Tax Credit
Information for Research Scientists
Important Research Links
Research Committee and Contacts
Sclerotinia Risk Assessment
Sclerotinia Stem Rot Checklist
For each risk factor, select the risk points that apply to your field
Risk factor
Possible answers
Risk points
NUMBER OF YEARS SINCE LAST CANOLA CROP
More than six years
Three to six years
One to two years
0
5
10
DISEASE INCIDENCE IN LAST HOST CROP
None
Low (1 to 10%)
Moderate (11 to 30%)
High (31 to 100%)
0
5
10
15
CROP DENSITY
Low
Normal
High
0
5
10
RAIN IN THE LAST TWO WEEKS
Less than 10 mm (0.4")
10 to 30 mm (0.4 to 1.2")
More than 30 mm (1.2")
0
5
10
WEATHER FORECAST
High pressure
Variable
Low pressure
0
5
10
PERCENT SCLEROTIA GERMINATION IN A LOCAL DEPOT
0 to 5%
6 to 25%
26 to 50%
51 to 100%
0
5
10
15

Sclerotinia Stem Rot Checklist

For each risk factor, select the risk points that apply to your field

Risk factor	Possible answers	Risk points
NUMBER OF YEARS SINCE LAST CANOLA CROP	More than six years Three to six years One to two years	○ 0 ○ 5 ◉ 10
DISEASE INCIDENCE IN LAST HOST CROP	None Low (1 to 10%) Moderate (11 to 30%) High (31 to 100%)	○ 0 ○ 5 ○ 10 ◉ 15
CROP DENSITY	Low Normal High	○ 0 ◉ 5 ○ 10
RAIN IN THE LAST TWO WEEKS	Less than 10 mm (0.4") 10 to 30 mm (0.4 to 1.2") More than 30 mm (1.2")	○ 0 ○ 5 ◉ 10
WEATHER FORECAST	High pressure Variable Low pressure	○ 0 ◉ 5 ○ 10
PERCENT SCLEROTIA GERMINATION IN A LOCAL DEPOT	0 to 5% 6 to 25% 26 to 50% 51 to 100%	○ 0 ○ 5 ◉ 10 ○ 15
TOTAL RISK POINTS FOR ALL RISK FACTORS =		**55**

Reset Form

Sclerotia depot study

- Are sclerotia producing apothecia?

Figure 1. Depot of 50 sclerotia inserted in nylon mesh ready for shipment.

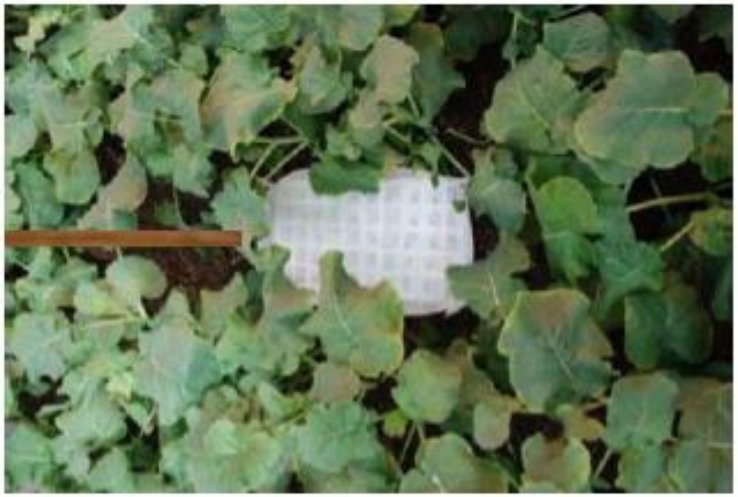

Figure 2. A sclerotia-depot of nylon mesh placed on the soil surface between rows of canola plants at the 3-5 leaf stage.

Source: Buchwaldt 2014

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Sclerotia depot study

- Are sclerotia producing apothecia?

Figure 3. A sclerotia-depot buried at 2 cm soil depth with the nylon lip barely visible (arrow).

Figure 4. Apothecia (circled) germinated from a single sclerotium at the base of a young canola plant.

Source: Buchwaldt 2014

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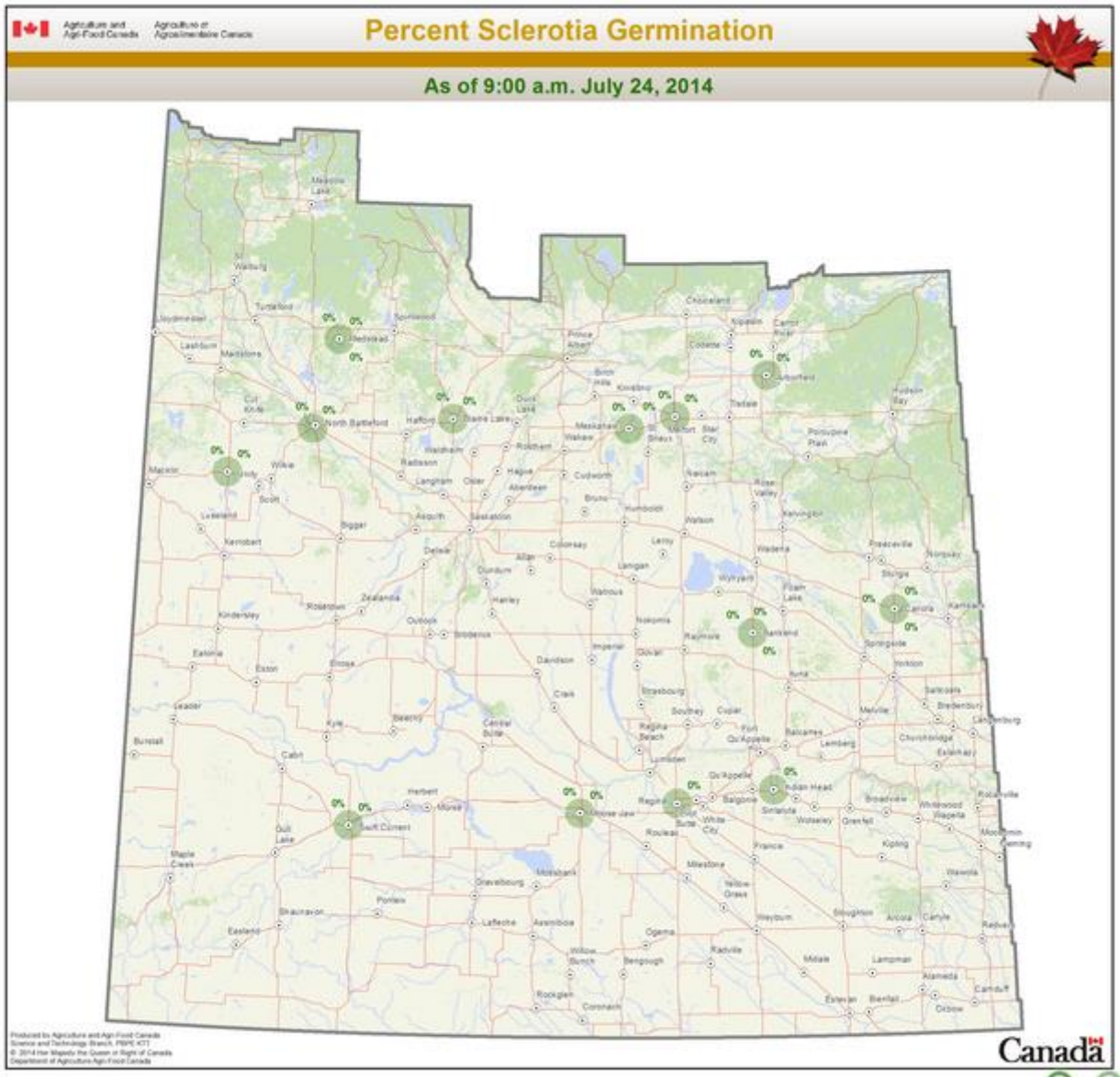


http://www.saskcanola.com/research/map.php

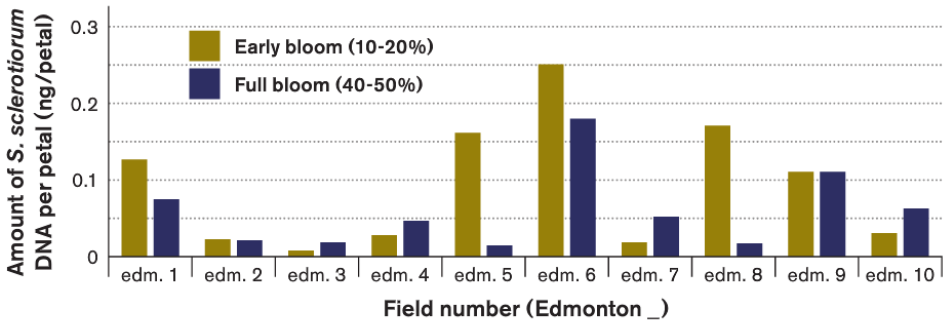
Canola petal infection study

- Can we examine canola petals to determine if ascospores are present?
  - The Petal Test Kit developed by the University of Saskatchewan in 1991, used a selected agar plate assay to culture *S. sclerotiorum* fungus from canola petals

Canola petal infection study

- Can we examine canola petals to determine if ascospores are present?
  - DNA test was developed by Agriculture and Agri-Food Canada in 2013, using qPCR to quantify the amount of S. sclerotiorum on infected petals.
  - Trials still being done to correlated this new test with field infection.

Figure 1. Quantitave PCR estimations of petal infestation for canola fields around Edmonton, AB in 2013



This graph shows the S. sclerotiorum *DNA content on petal samples, as measured by qPCR, from various fields around Edmonton in 2013. These quantitative tests tell us that the amount of inoculum is not the same in every field, thus the disease risk is not the same in every field. Factors such as canopy density and weather conditions can have an important impact.*

Source: B. Ziesman, graduate student

Weather Based Assessment of Sclerotinia Stem Rot in Canola

- Study at the University of Manitoba to developp a means of predicting sclerotinia stem rot based on weather conditions
  - May allow for more accurate use of fungicides
- Used standard weather conditions and microclimate measures and trapping ascospores.
- Found no correlations between weather and microclimate variable and ascospore release

Other New Research

- Characterization of defense genes underlying quantitative resistance loci (QRL) to *Sclerotinia* stem rot in Asian *Brassica napus* and transfer of resistance to Canadian spring type canola
  - Lone Buchwaldt, AAFC Saskatoon
  - Currently provided 4 new resistant B. napus lines to canola breeding companies in Canada
- Resistance to *Sclerotinia sclerotiorum* necrosis inducing proteins in canola
  - Dwayne Hegedus, AAFC Saskatoon
  - Currently identified 75 proteins involved in necrosis

Other New Research

- Operational models to forecast canola growth stage, sclerotinia risk, and yield in Western Canada
  - Rishi Burlakoti, Weather Innovations

Sclerotinia stem rot summary

- Sclerotinia stem rot of canola is variable year to year and region to region, but likely related to moisture conditions.
- Many tools to control sclerotinia stem rot have been developed, but fungicides remain the best of these.
- New research and new resistant cultivars will improve our ability to manage this disease into the future.

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Blackleg

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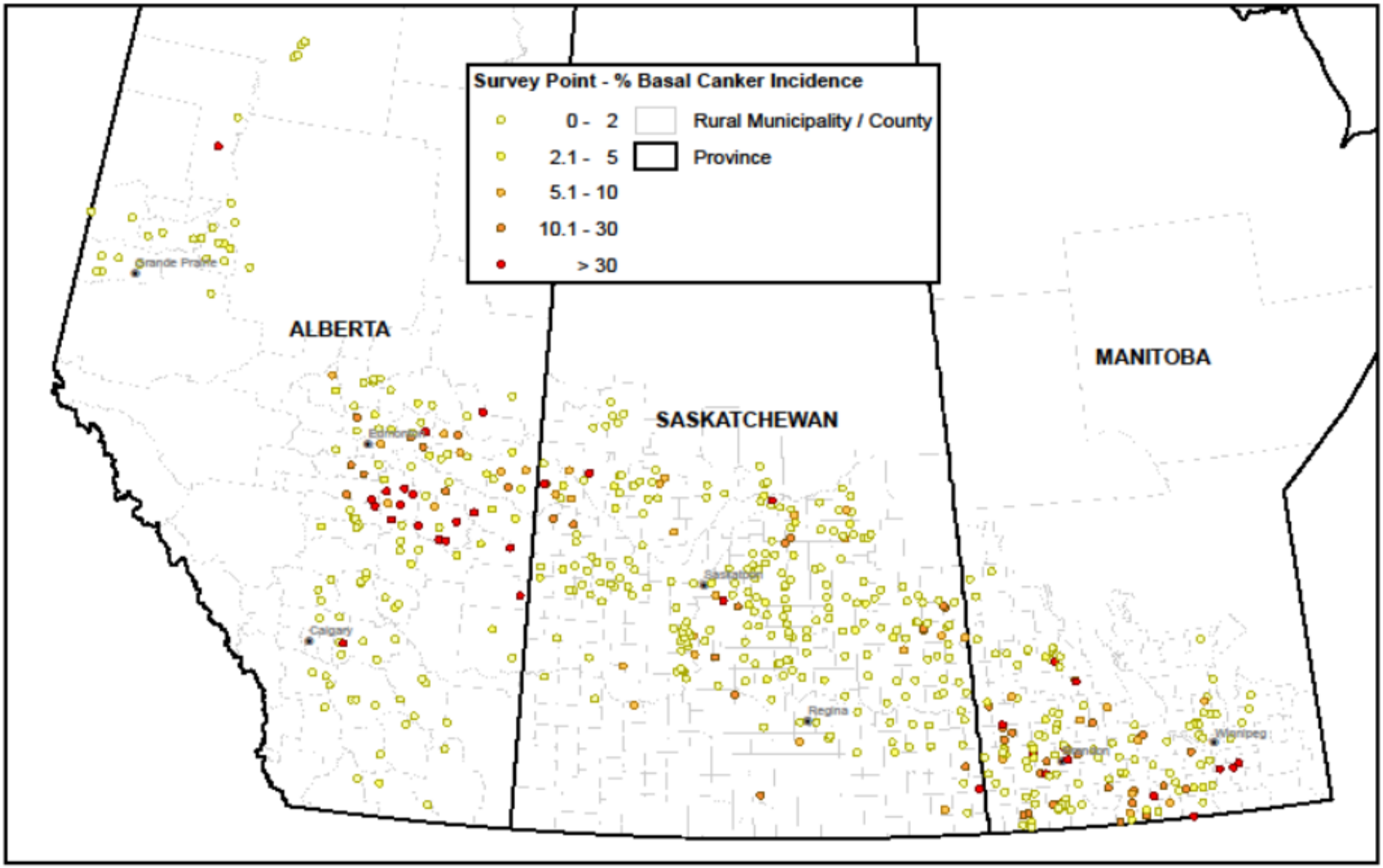
Average Per Cent Blackleg Incidence in Canola - 2010



Saskatchewan Ministry of Agriculture

0 50 100 200 300 400 500

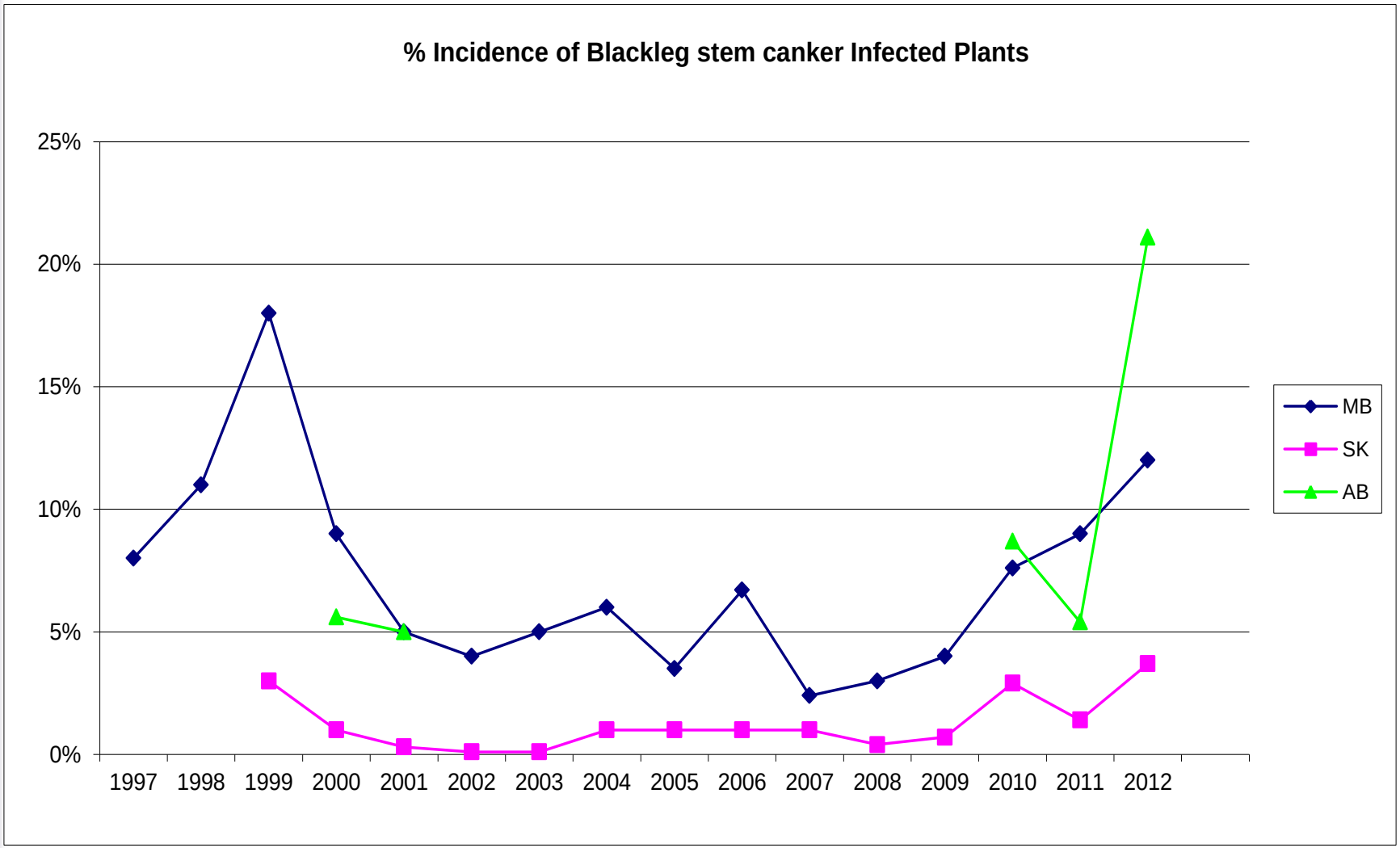
Kilometers

Projection: Canada Lambert Conformal Conic Datum: NAD83

N W E S

Data source:
Canola Survey Data - Crops Branch
Collaboration with: Agriculture and Agri-Food Canada, Manitoba, Government of Alberta, canolacouncil

Prepared by: Geomatics Services Date: April 4, 2011


% Incidence of Blackleg stem canker Infected Plants
25%
20%
15%
10%
5%
0%
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
MB
SK
AB

Why is blackleg a concern?

- Currently, infection rates indicate that blackleg is a minor disease in Canada.
- Historically, blackleg was the most important canola disease in Canada, but blackleg resistance has reduced this disease's impact.
- Blackleg has very high evolutionary potential to overcome current sources of resistance.

Blackleg Research Priorities for Canada

1. Find new sources of blackleg resistance
2. Identify and survey races (avirulence genes) in *L. maculans* in Canada to measure and monitor their distribution over time.
3. Identify major resistance genes in commercial cultivars of *B. napus*
4. Quick field diagnostics to identify avr's present in the field

Blackleg Research Priorities for Canada

5. Correlation between plant infection and yield loss
6. Measure durability of each resistance gene
7. Understand how to best use quantitative resistance with major gene resistance
8. Sequence resistance genes
9. Identify and characterise quantitative resistance

Population dynamics of *Leptosphaeria maculans* on the Canadian Prairies

Peng, Fernando and Kutcher

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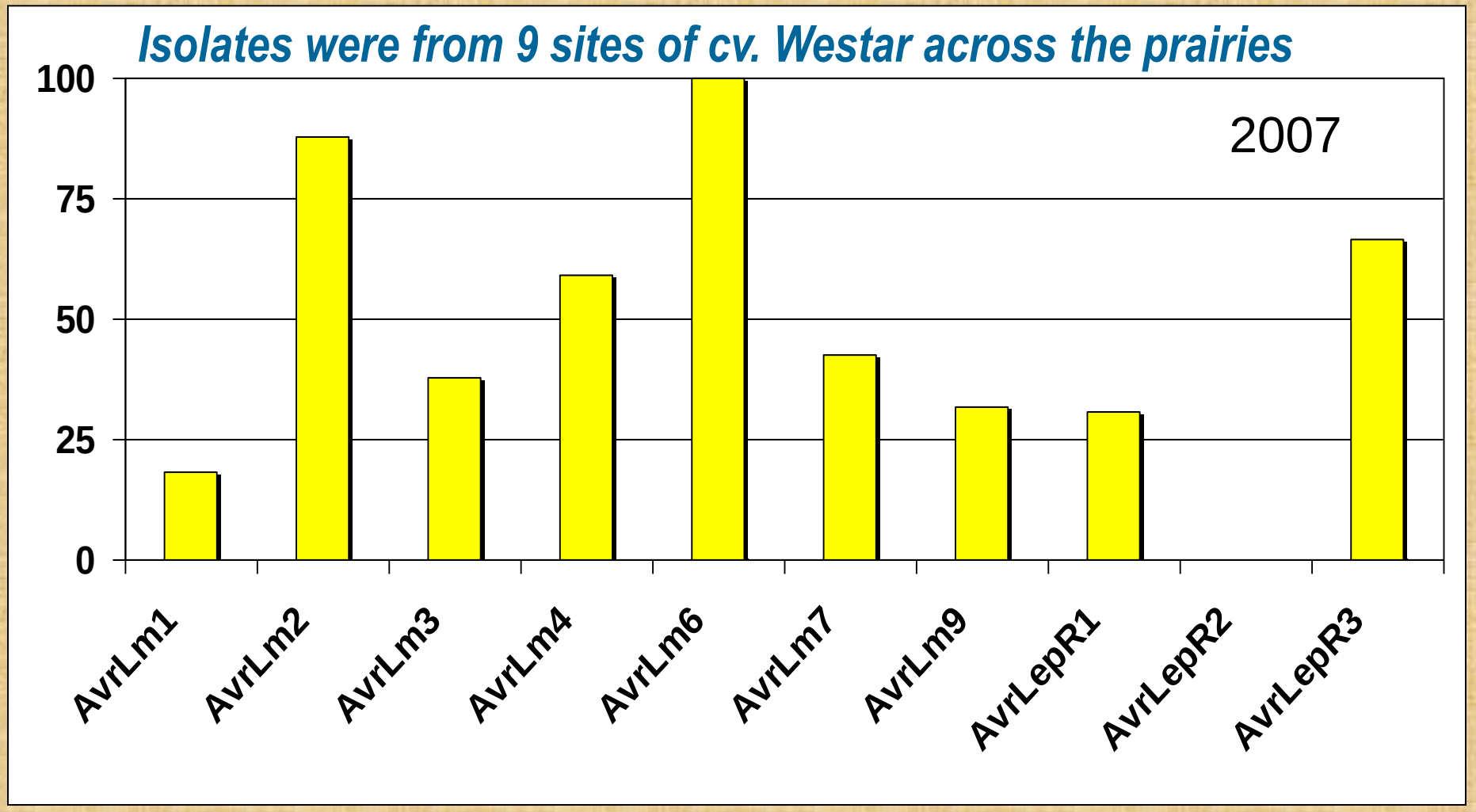
Assessment of *L. maculans* isolate with host differentials

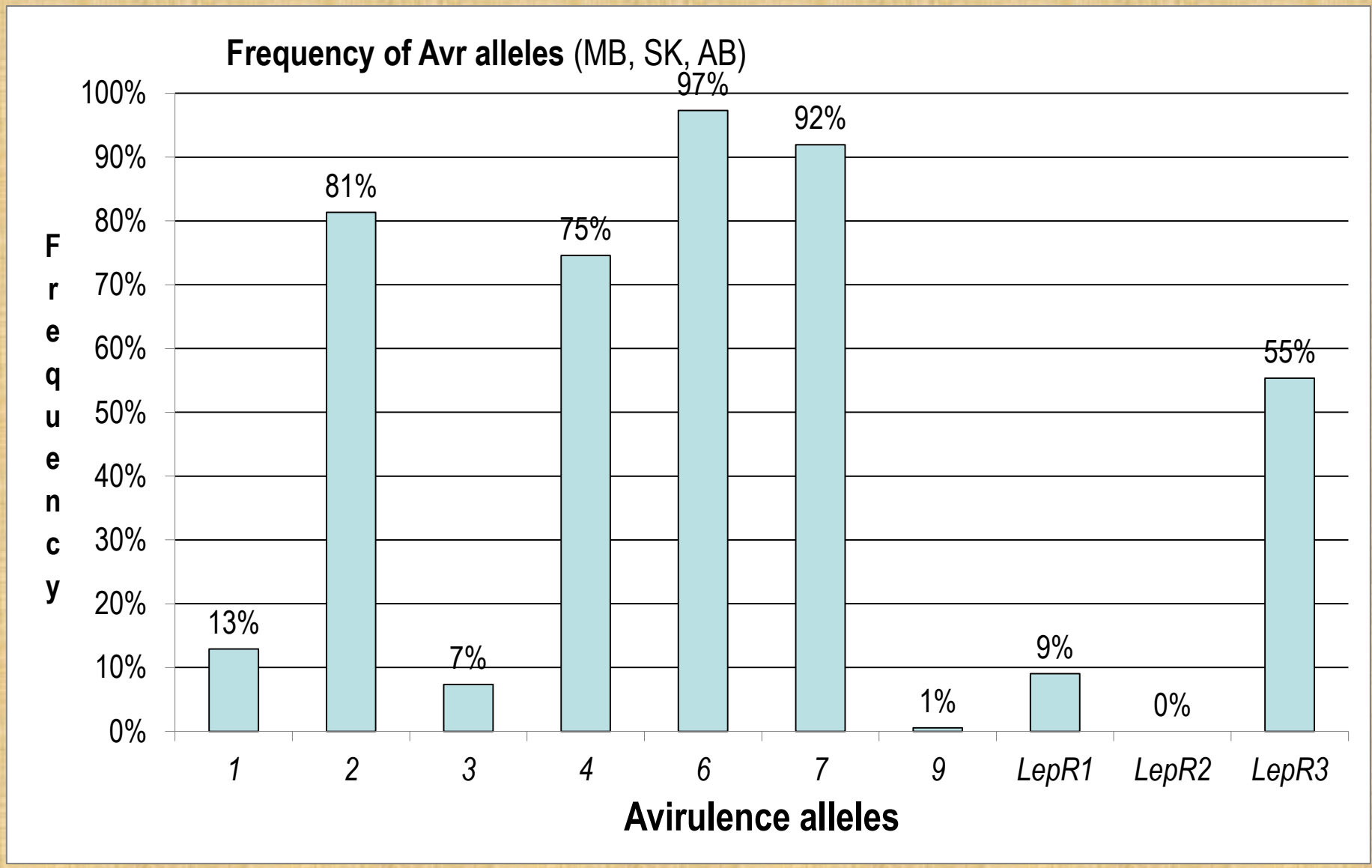
3 5 7 9

0-9 rating scale

Percentage of 500 *L. maculans* isolates carrying each of the known Avr allele (MB, SK, AB) – HR Kutcher



L. Maculans race structure -2010 overall



Current *L. maculans* race structure –2010

Most common races

Race	# of isolates	Frequency	
Av-2-4-6-7	54	30.5%	
Av-2-4-6-7-Lep3	38	21.5%	52%
Av-2-6-7-Lep3	14	7.9%	
Av-1-4-6-7-Lep3	10	5.7%	
Av-2-6-7	9	5.1%	71%
Av-2-3-6-Lep3	8	4.5%	
Av-2-4-7	6	3.4%	
Av-1-4-6-7-Lep1-Lep3	5	2.8%	
Av-2-4-6-7-Lep1	3	1.7%	
Av-4-6-7-Lep3	3	1.7%	
Av-6-7-Lep3	3	1.7%	
Av-6-7	3	1.7%	88%

Identifying major resistance genes and adult plant resistance against blackleg disease in Canadian canola germplasm

Dilantha Fernando

Department of Plant Science

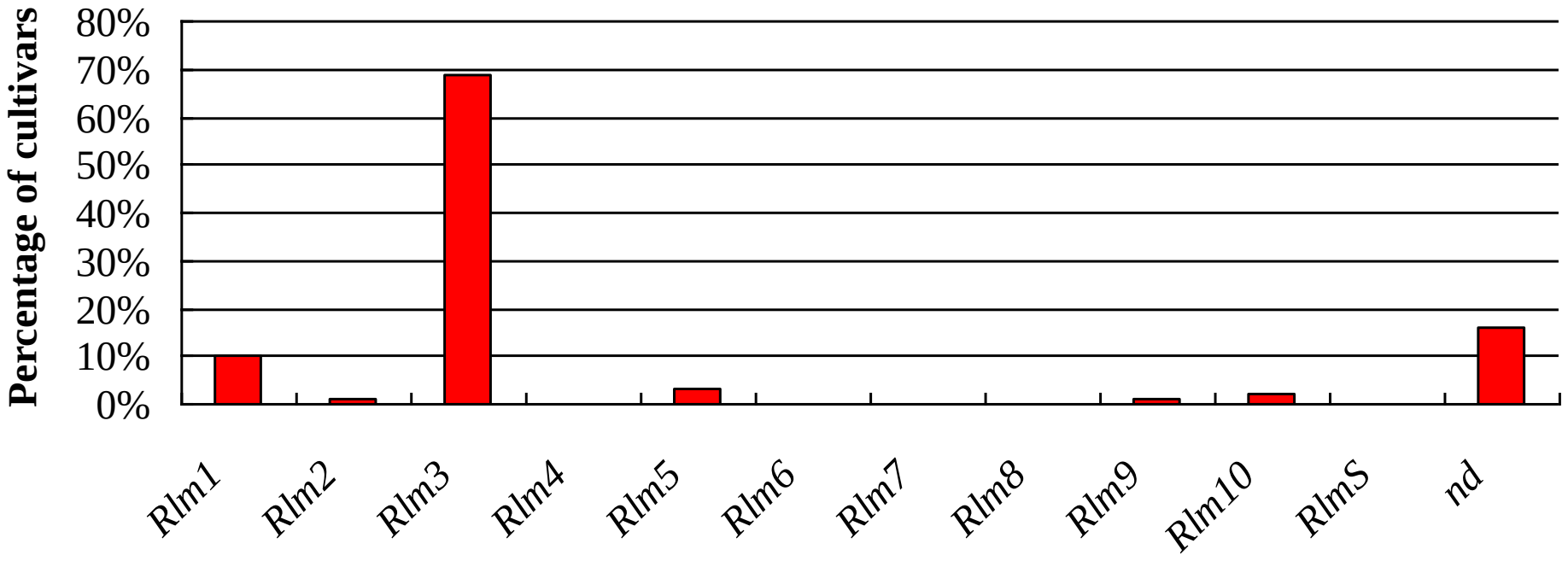
University of Manitoba

UNIVERSITY OF MANITOBA

FACULTY OF AGRICULTURAL AND FOOD SCIENCES

2012 Stubble collected form heavily infected fields in Manitoba

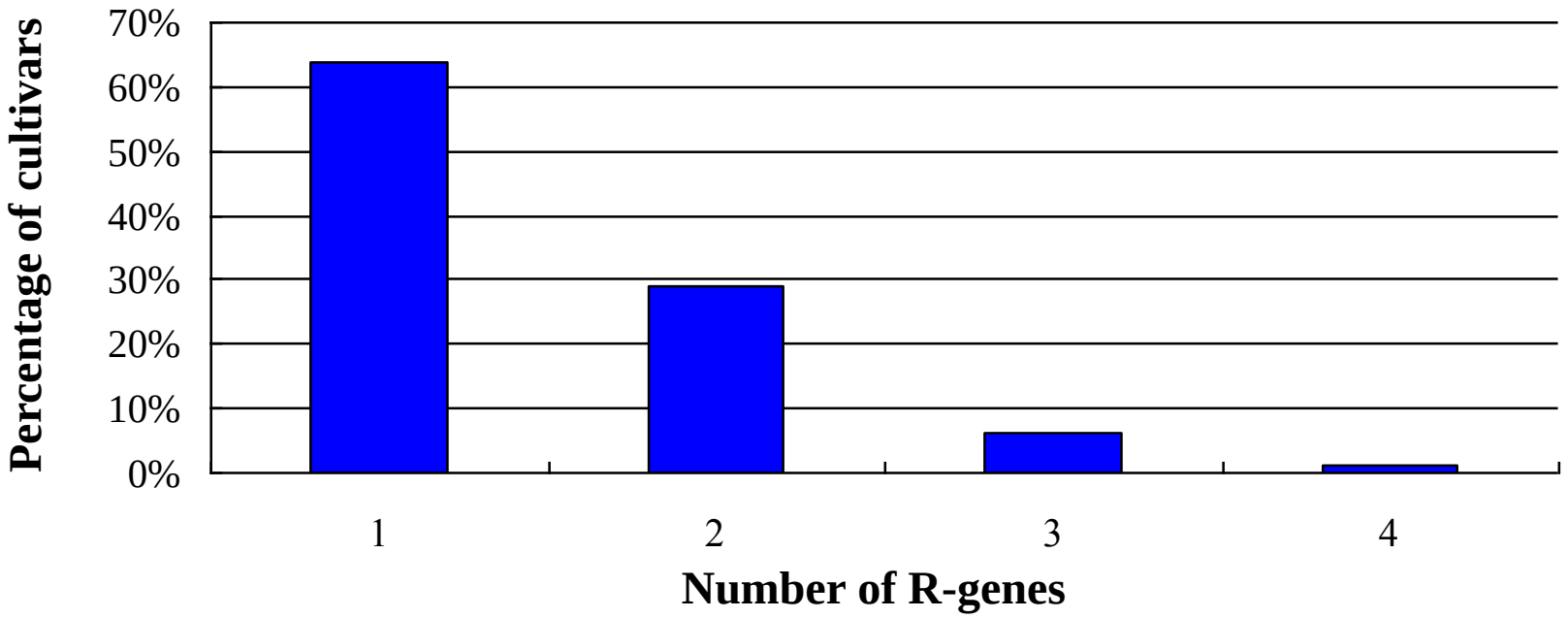
R-genes in 87 canola cultivars/lines



Percentage of cultivars/lines carrying each R-gene (in 87 canola cultivars/lines)

University of Manitoba

R genes in 87 canola cultivars/lines



Percentage of cultivars/lines carrying different numbers of R-genes

University of Manitoba

R-genes in cultivars/seeds collected from 92 field locations

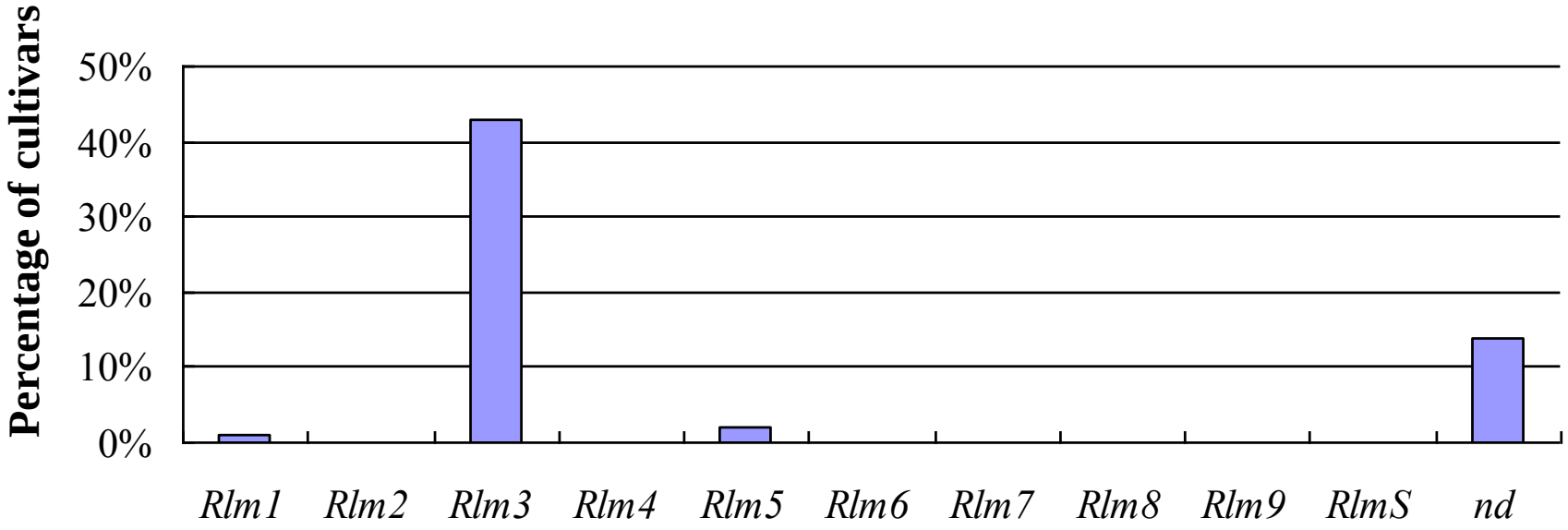
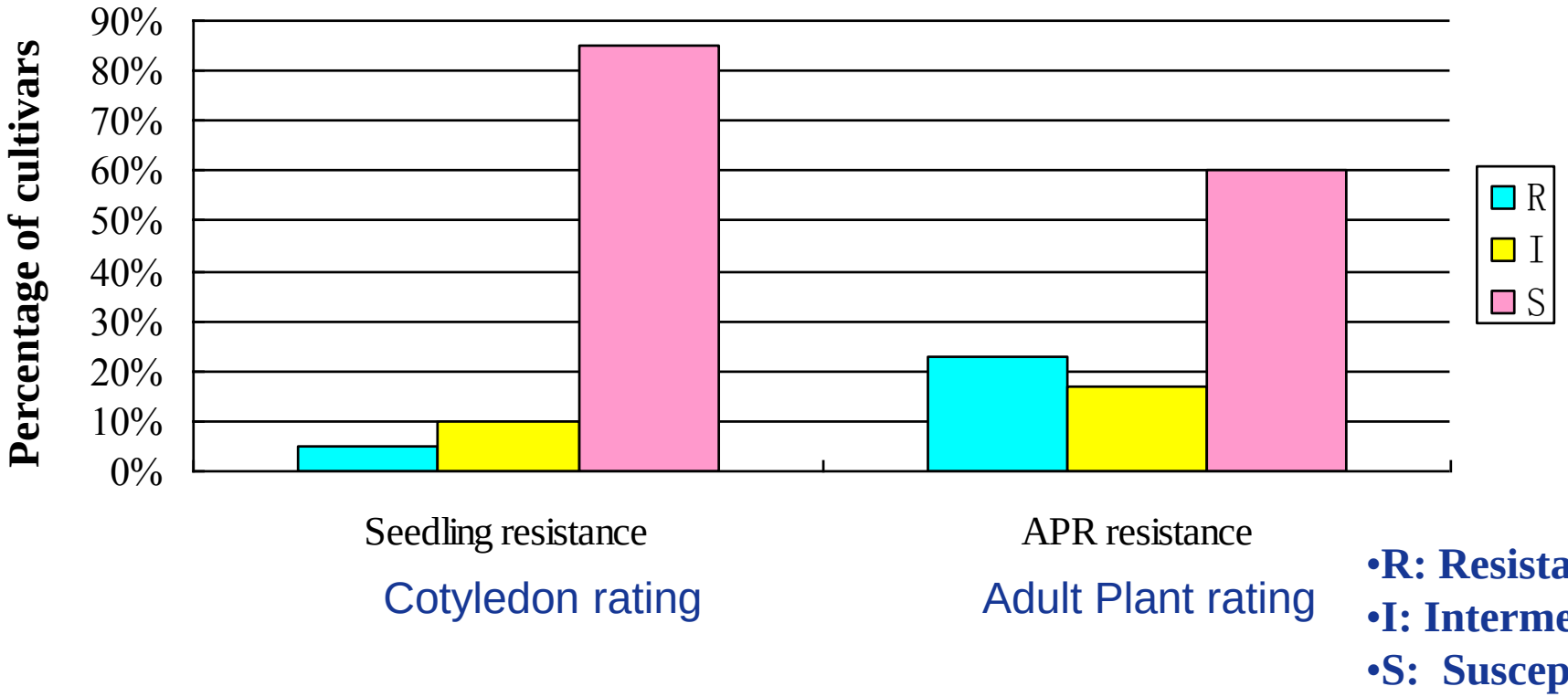


Fig. 4. Percentage of locations carrying each R-gene (from 92 field locations)

Preliminary results on adult plant resistance



- **R: Resistant**
- **I: Intermediate**
- **S: Susceptible**

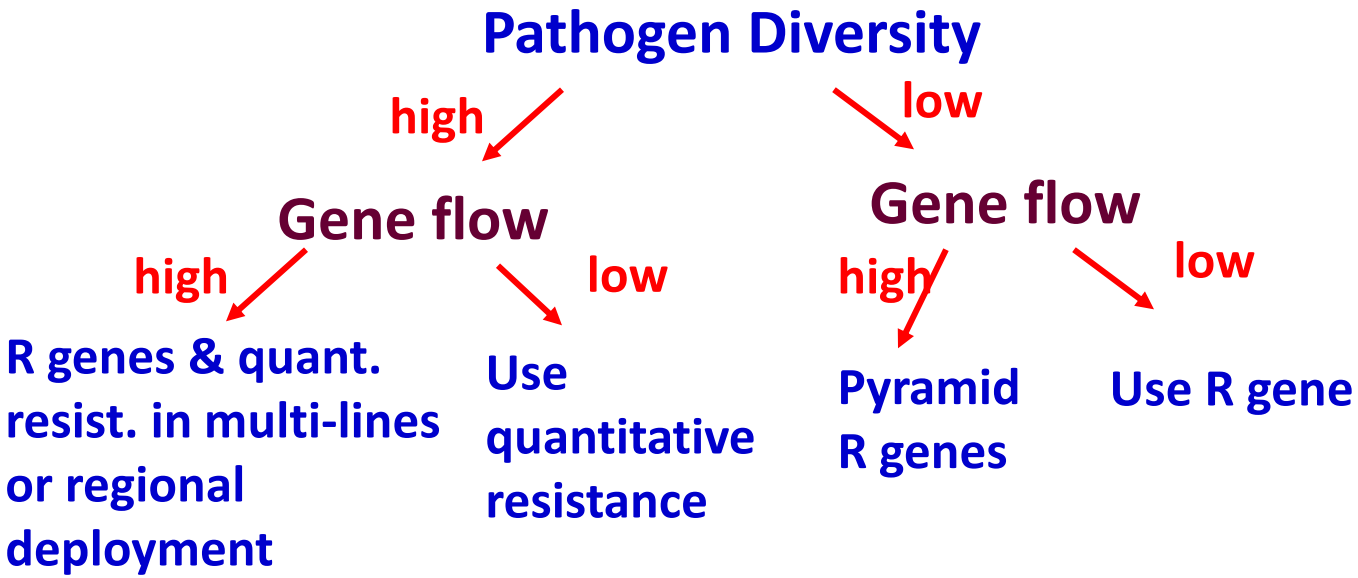
Comparison of performance of 78 canola cultivars/lines at seedling stage and adult plant stage

University of Manitoba

Conclusions

- **Most canola cultivars/lines carry at least one R-gene against blackleg from 87 characterized cultivars/lines.**
- **A few lines carry three or four R genes, but most cultivars/ lines carry only a single R-gene.**
- ***Rlm3* is the most frequently found, and other R genes are rare, which means *diversity of R-genes in Canadian canola germplasm is relatively poor*.**
- **A combination of adult plant resistance (APR) and new sources of resistance are needed for durable blackleg resistance.**
- **Rotation of R genes is going to be challenging with existing cultivars, *however, if strategically implemented – is still a possibility*.**

Ensuring Resistance Durability



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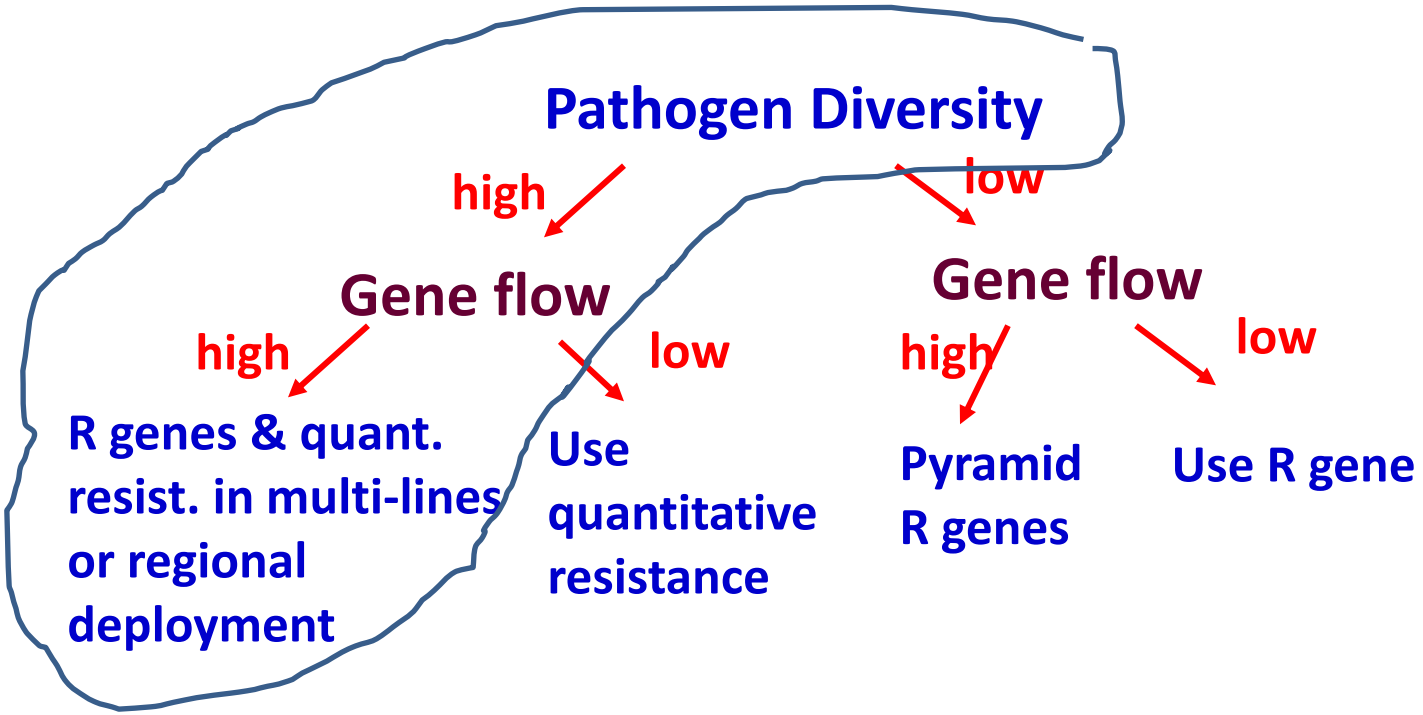
McDonald BA. and Linde C. Euphytica 124 (2): 163-180, 2002

Ensuring Resistance Durability



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McDonald BA. and Linde C. Euphytica 124 (2): 163-180, 2002

Blackleg – Avoid Risk

	Low Risk	High Risk
Scouting	Spring, summer, and fall	No scouting
Crop Rotation	Canola 1 in 4	Canola 1 in 2 years or less
Variety Rotation	New variety	Same variety
Blackleg Resistance Label	R or MR	MS or S
Fungicide	Yes	No
Seed Source	Certified treated seed	Bin-run, untreated
Weed Control	Control brassica weeds	No weed control

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Blackleg – Key Messages

- **Assess your risk**
  - Avoid planting canola in high risk situation
- **Add diversity to farming operation**
  - Rotate crops
  - Rotate varieties
  - Rotate fungicides
- **Make strategic variety selections when data is available**
- **Learn to ID blackleg**

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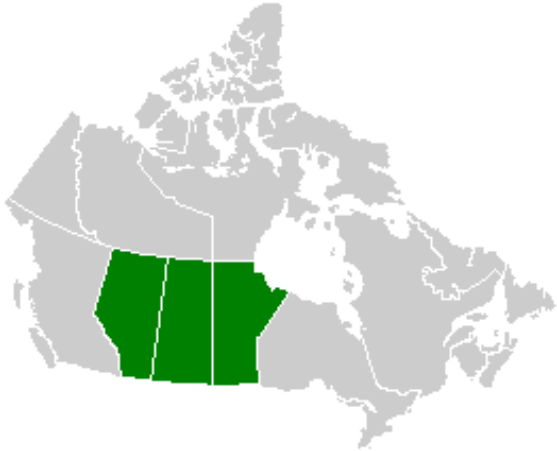
Clubroot

Clubroot

- Is a new pest in canola in Western Canada
  - First found in 13 fields in 2003 in Alberta
    - Now estimates are that it is present in thousands of fields in Alberta
  - First found in Saskatchewan in 2008
  - First found in Manitoba in 2012
- Yield losses can be 100% in severely infested fields



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2003

12 fields
1 county

Counties with confirmed clubroot (2003)

Strelkov et al.

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2005

41 fields
4 counties

Counties with confirmed clubroot (2005)

Strelkov et al.

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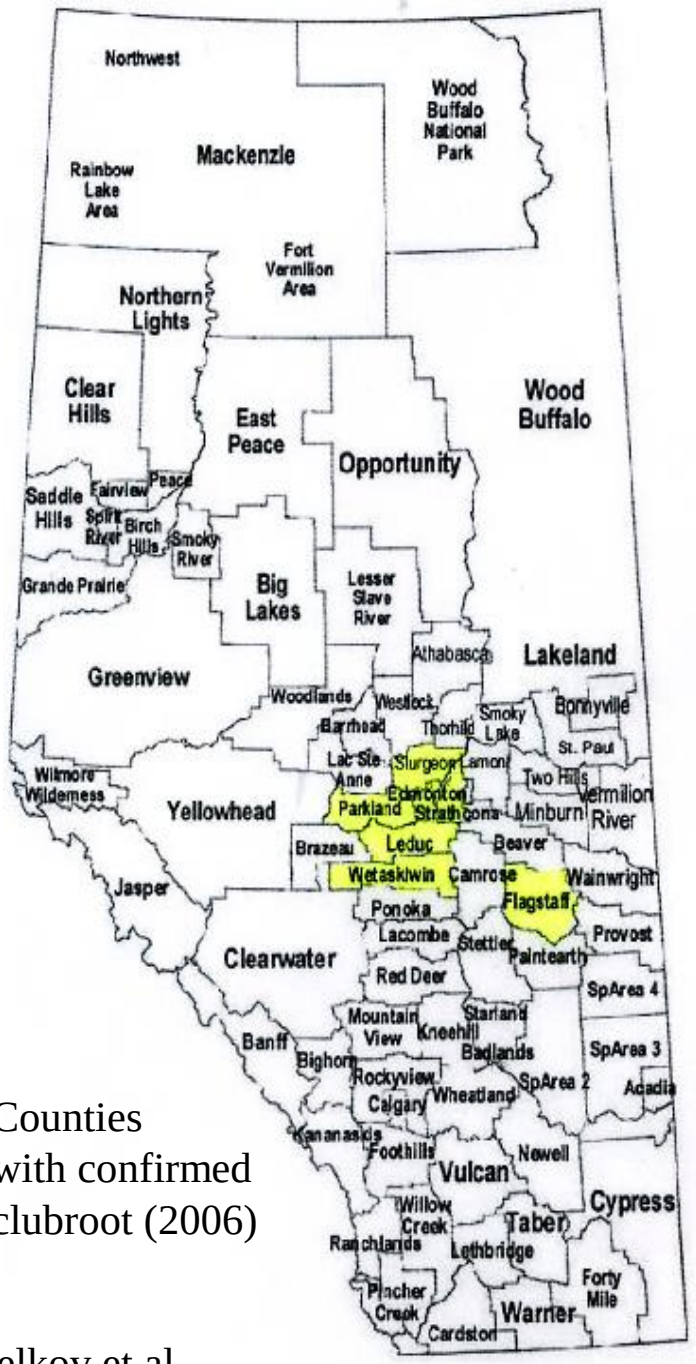
2006

113 fields
6 counties



Counties with confirmed clubroot (2006)

Strelkov et al.

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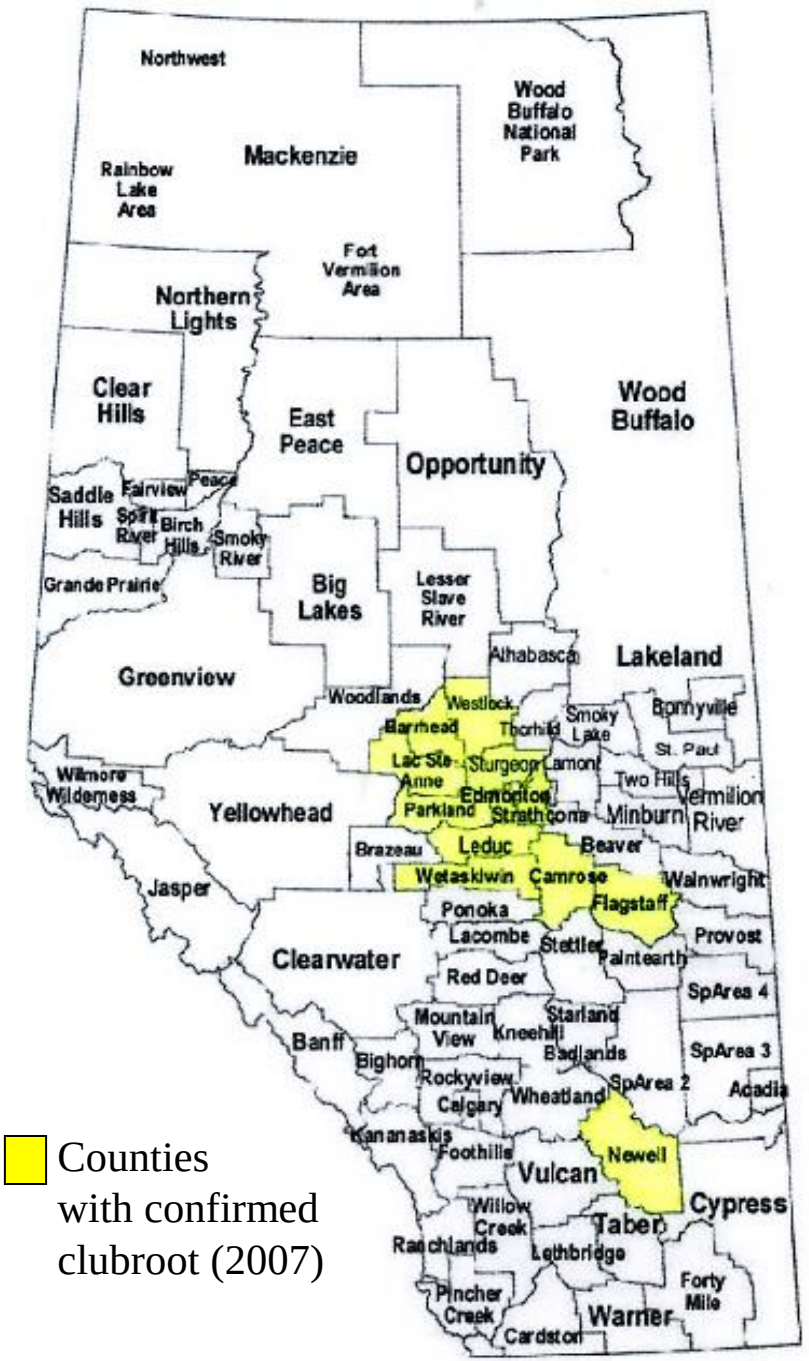
2007

171 fields
11 counties



Counties with confirmed clubroot (2007)

Strelkov et al.

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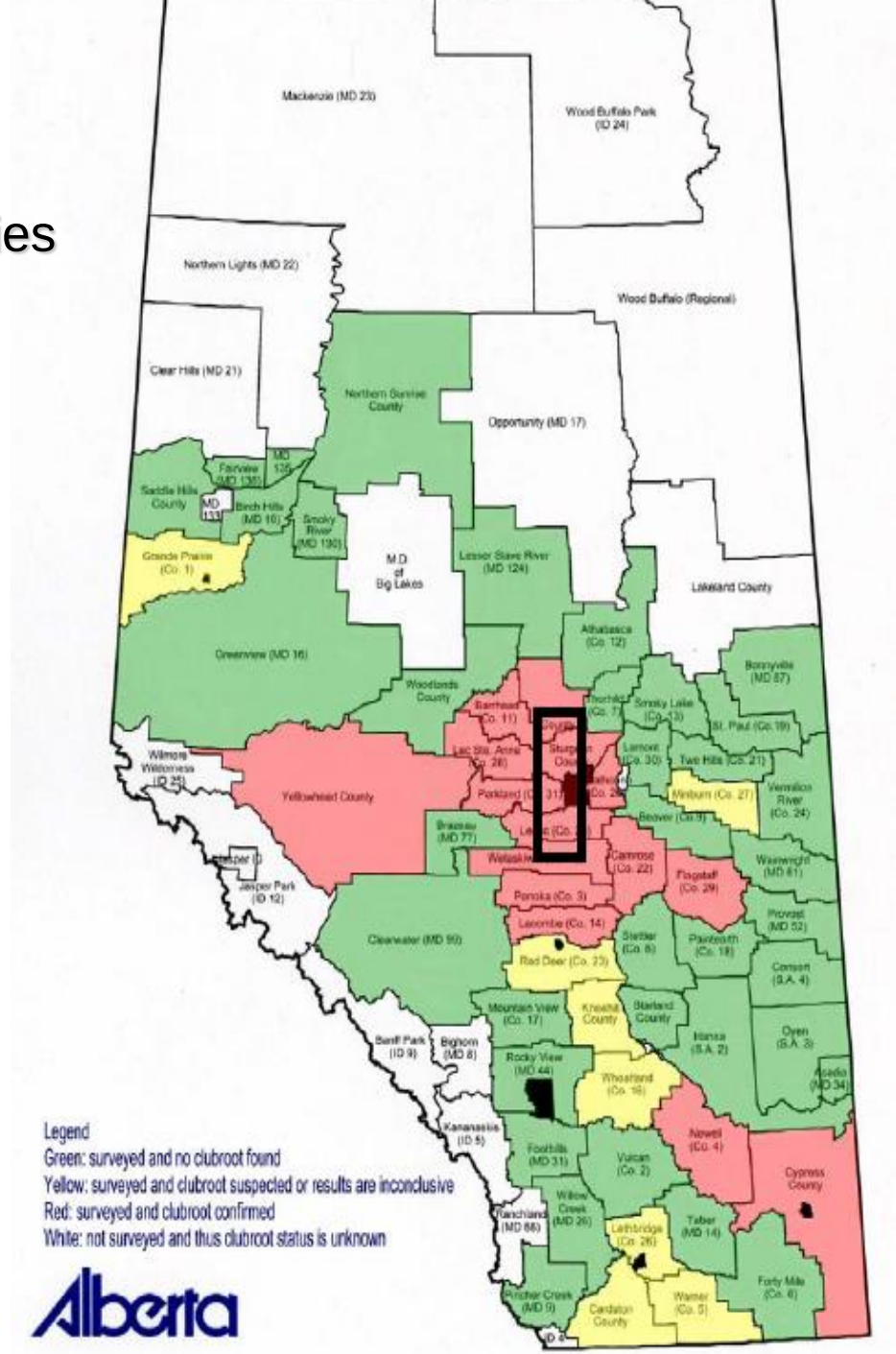
2008

> 400 fields

15 (23?) counties



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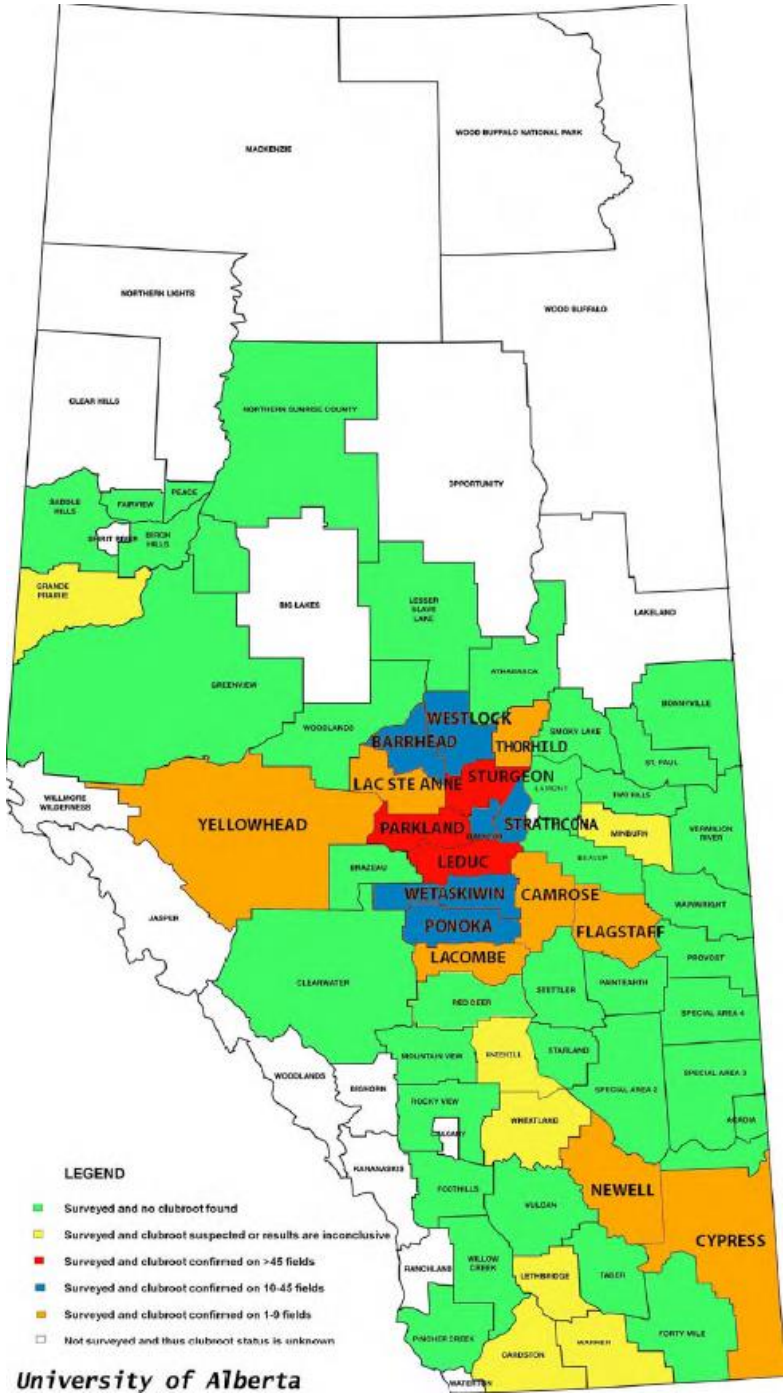
2009

> 450 fields

17 (24?) counties



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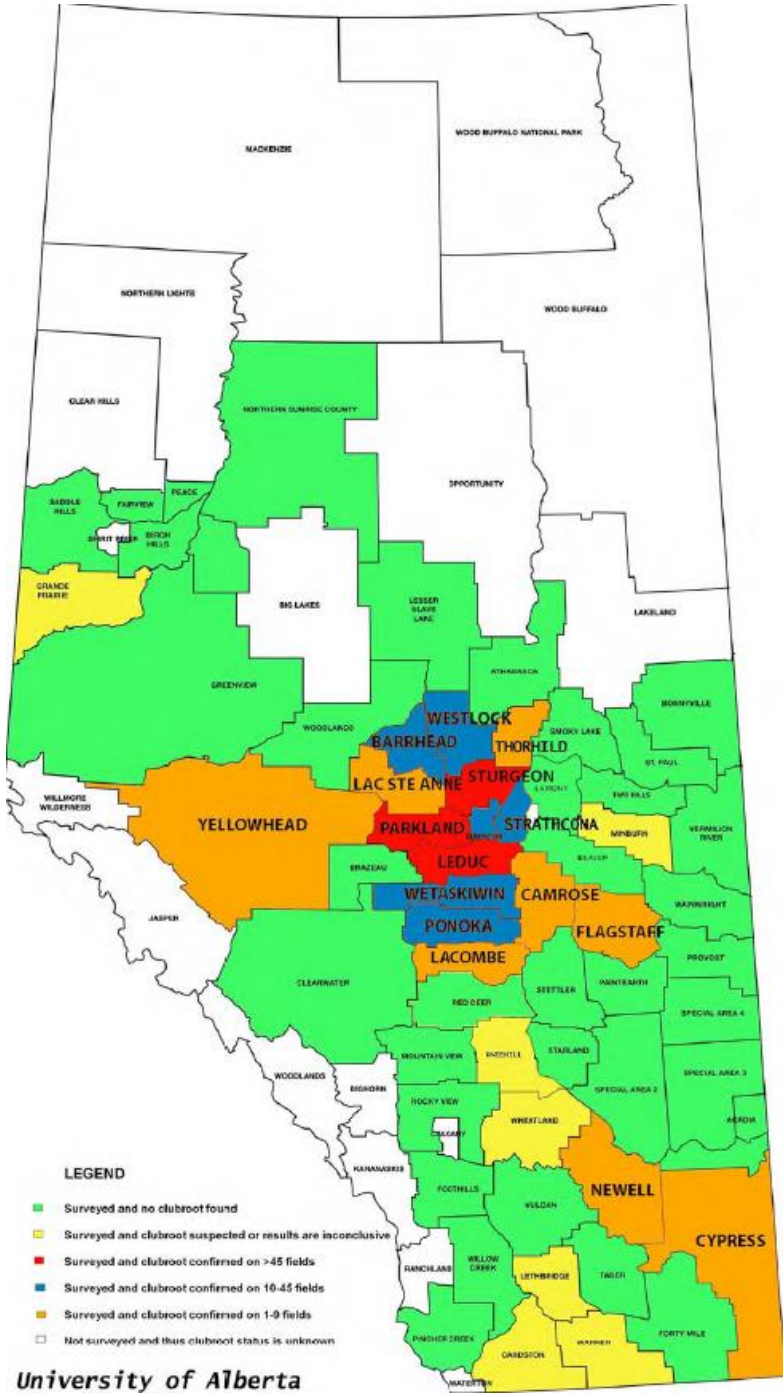
2009

> 450 fields

17 (24?) counties



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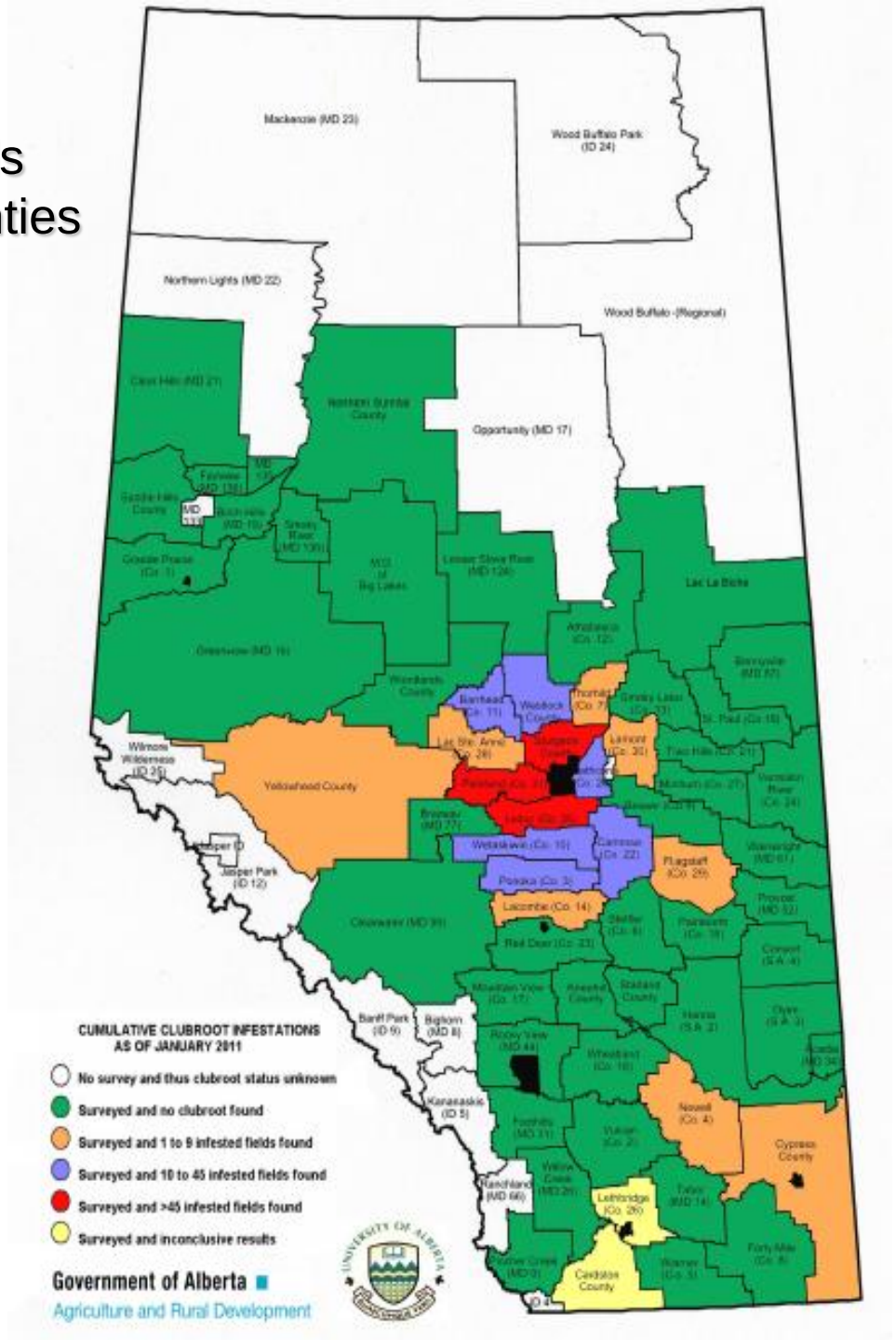
2010

> 550 fields

19 (21?) counties



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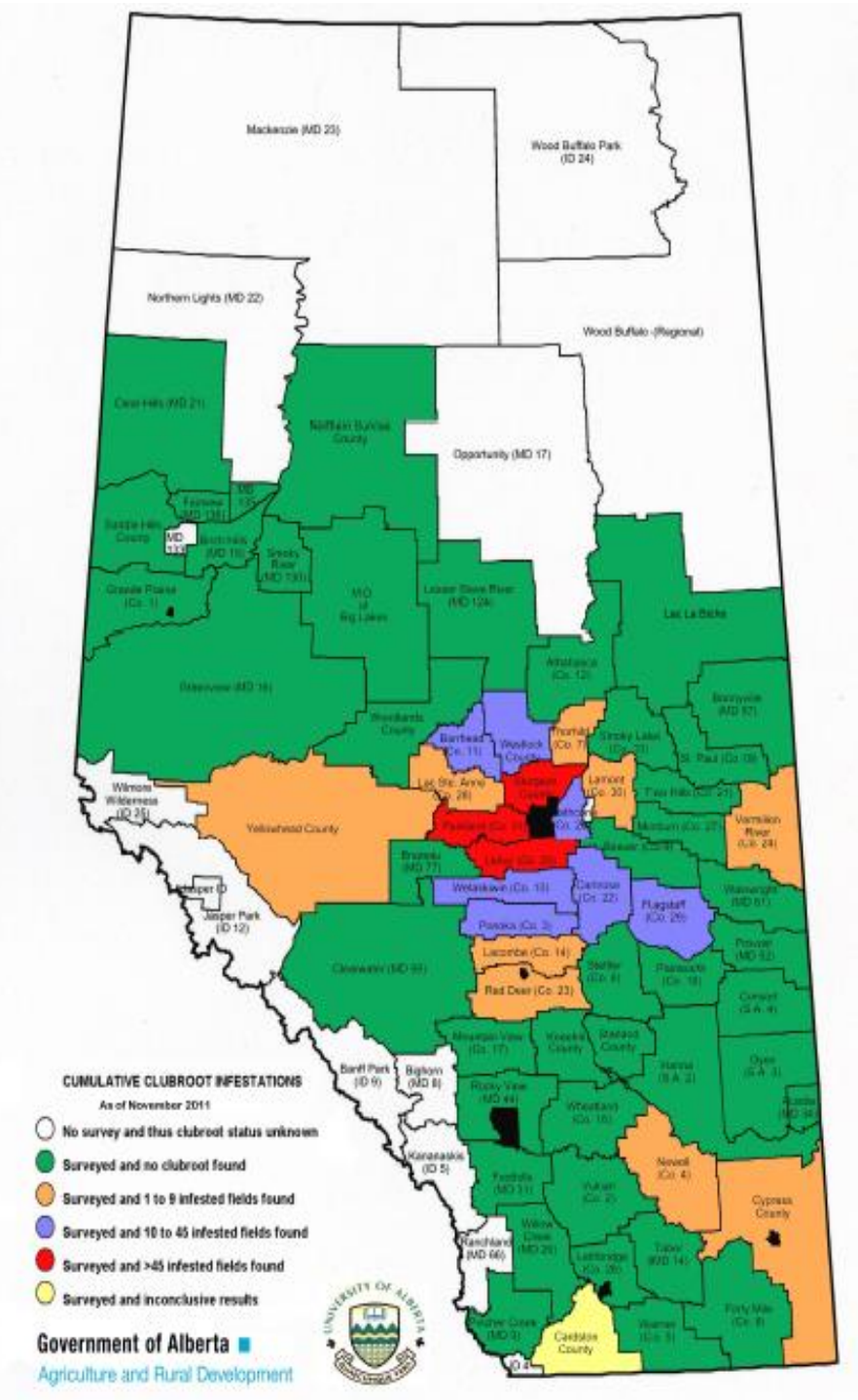
2011

> 830 fields

21 counties



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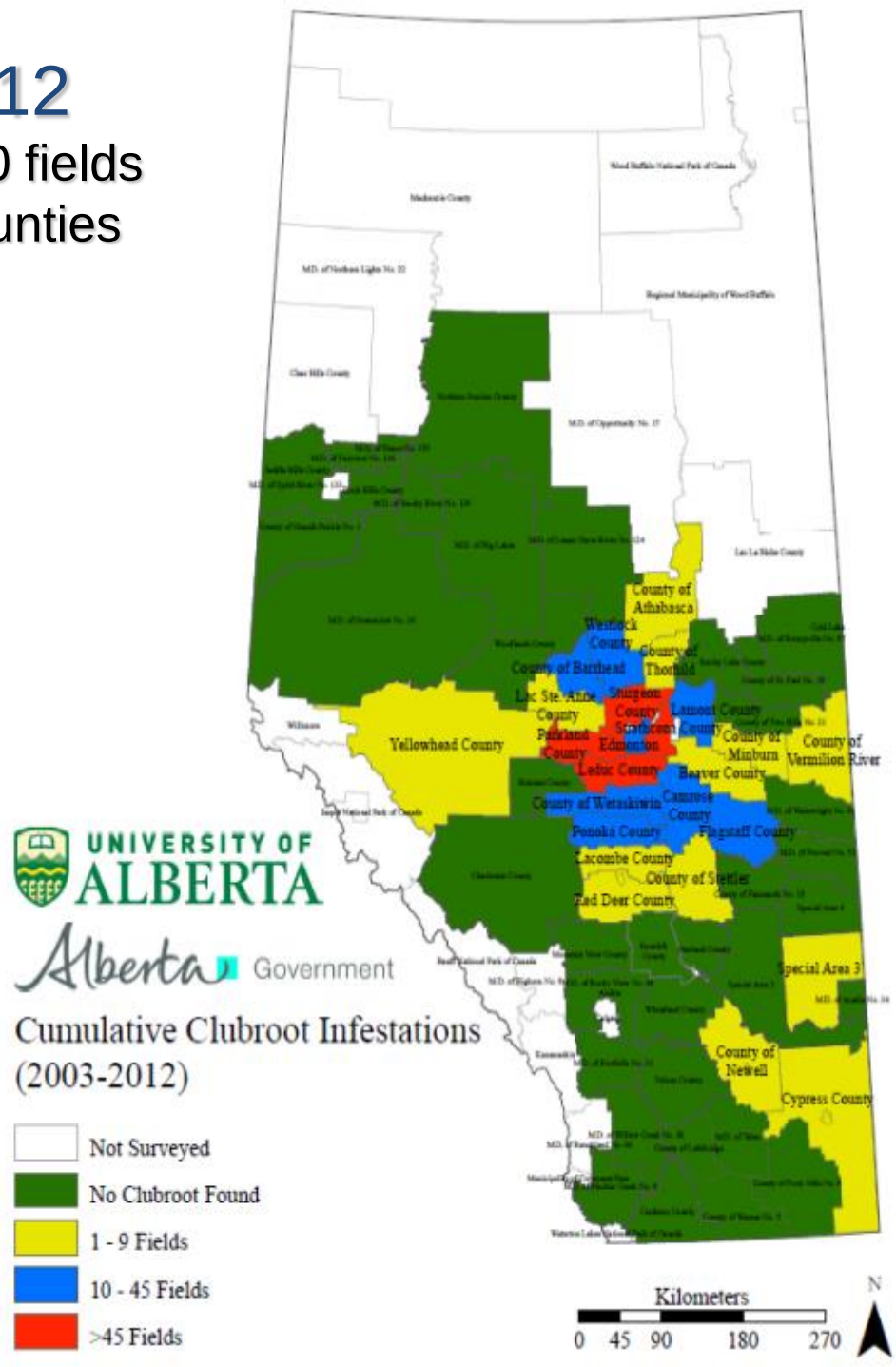
2012

> 1000 fields
26 counties



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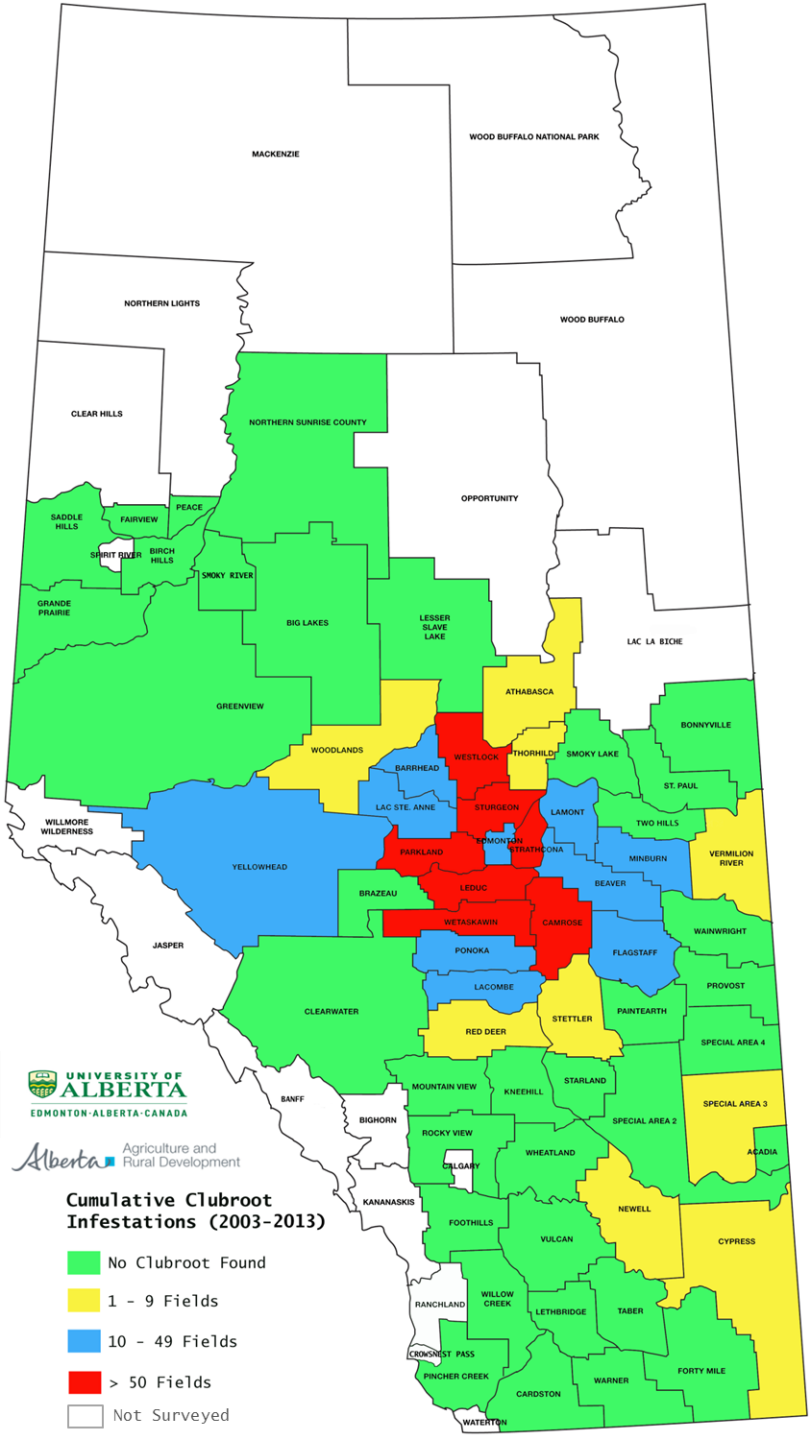
2013

1483 fields
27 counties



Clubroot is bad!

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Photo courtesy of Dr. Ron Howard

Why?

1. No-one was scouting for clubroot
2. No-one was sanitizing their equipment
3. Everyone was growing susceptible cultivars in a tight rotation

Photo courtesy of A. Van Beers

Risks of not growing a resistant cultivar when there is clubroot present

Resistant

Susceptible

Photo courtesy of A. Van Beers

Clubroot Resistance may not be durable

- In May 2014, fields in Alberta were identified where clubroot resistance had failed

Current recommendations to control Clubroot

1. Crop Rotation
2. Resistance
3. Early seeding
4. Equipment sanitation
5. Early identification
6. Quarantine/isolation
7. No tillage
8. Brassica weed control
9. Clean inputs
10. Planning:
    - not just canola problem
    - asses risk
    - develop a management plan

Summary

- Sclerotinia stem rot, blackleg and clubroot can be managed using different strategies.
- Canola growers need to be well educated in order to control these diseases effectively
  - Disease identification
  - Disease management options
  - Current research and data from trials

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Canola Encyclopaedia