CLUBROOT RISK MITIGATION

Clubroot Summit: Pathology and Surveillance

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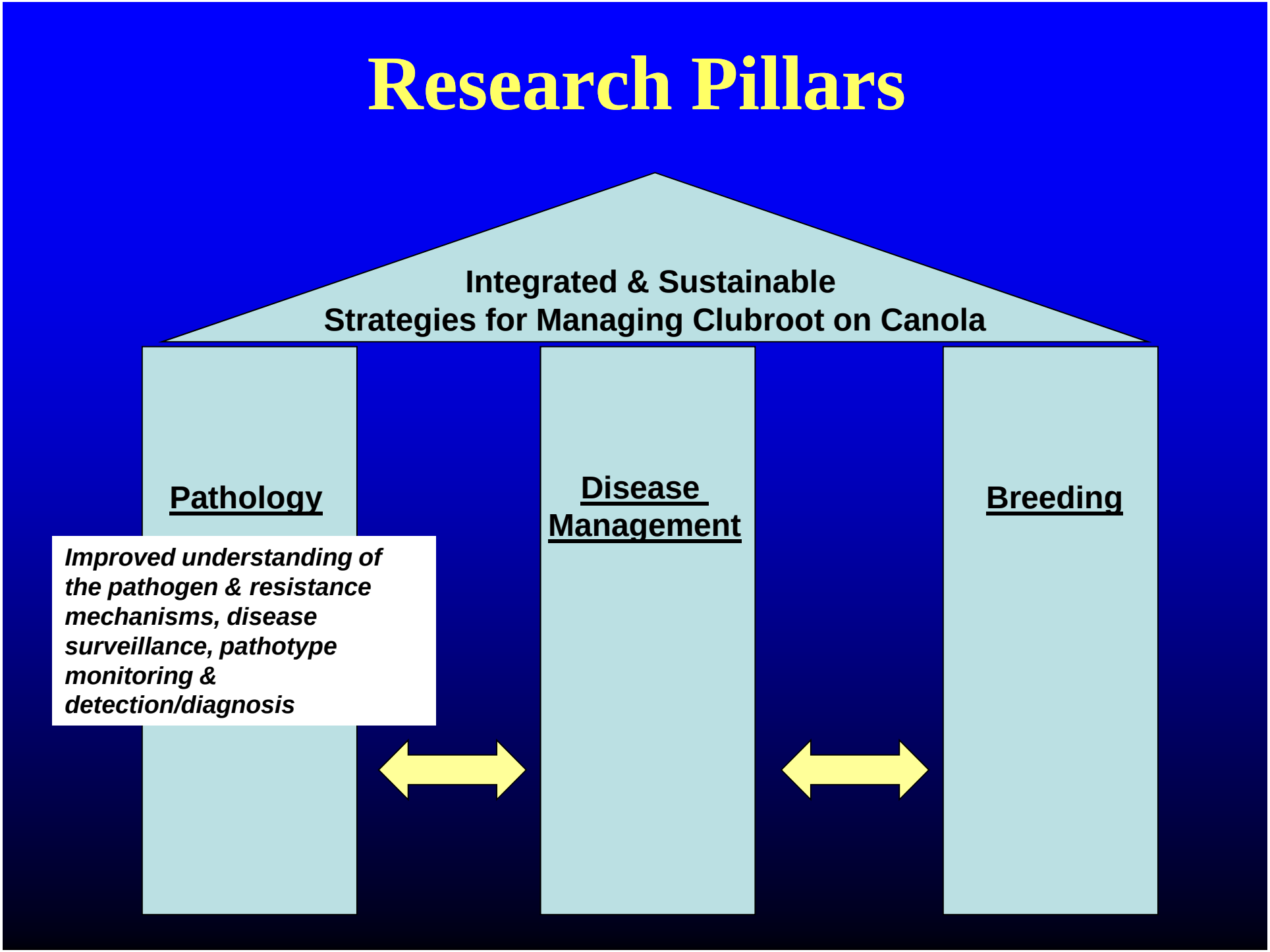
March 7, 2012

Research Pillars



Outline of Presentation

- Clubroot surveillance in 2011
- Studies on dispersal in dust & water
- Improved detection and quantification
- Resistance stewardship
- Additional research
- Summary
- Acknowledgments

Clubroot Surveillance

- 447 commercial canola crops in 21 counties visited in 2011
  - 23 were confirmed to be cropped to resistant hybrids
  - 424 cropped to susceptible hybrids or hybrids of unknown resistance
- Some counties also conducted their own surveys

Survey Findings

- 103 of 447 canola crops found to be clubroot-infested
  - All were new records in the specific fields
- Another 162 new records identified in independent surveys by Barrhead, Leduc, Parkland and Strathcona Counties
- Total of 265 new cases of clubroot identified in 2011

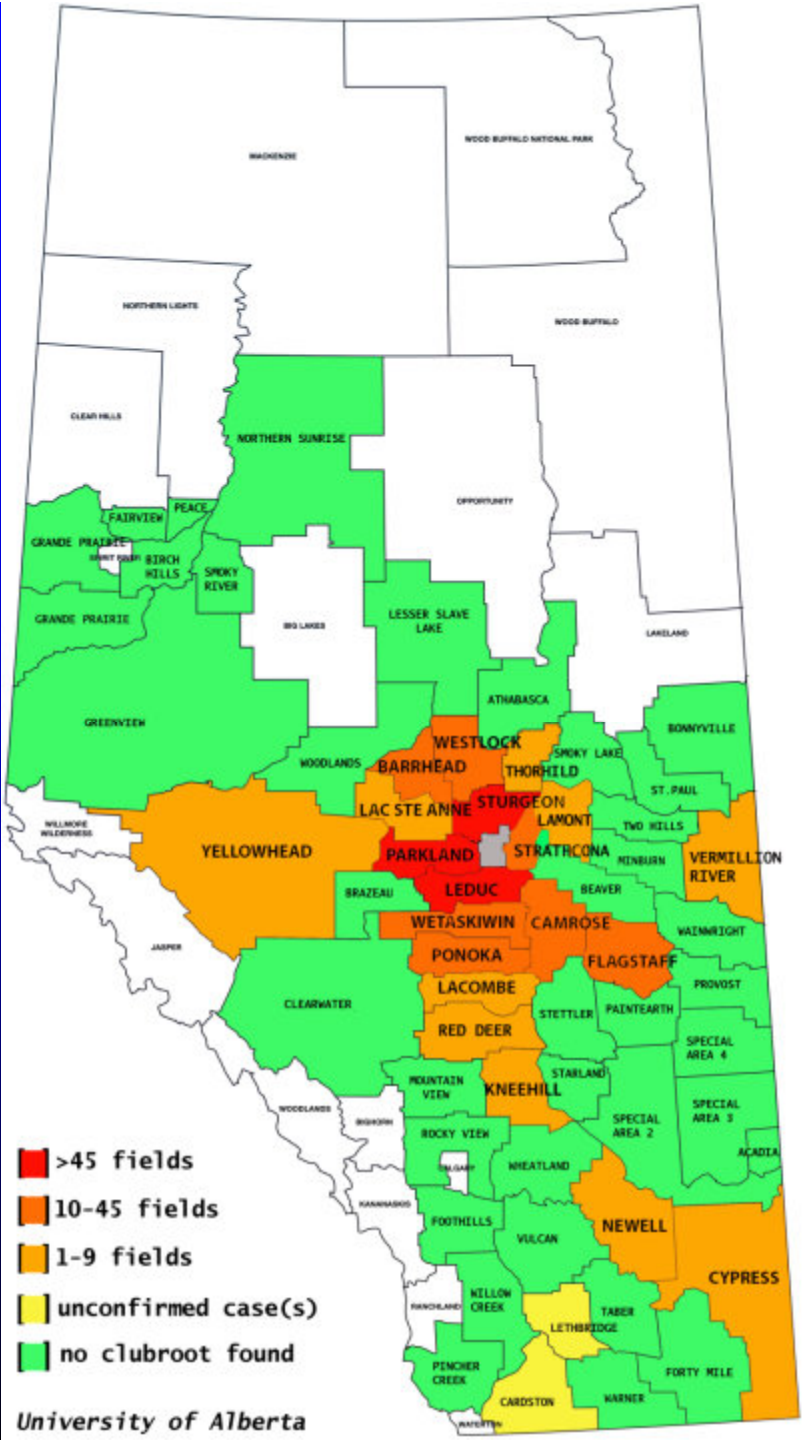
Field Situation - 2011

- Clubroot found in 9 of 23 crops sown to resistant hybrids & 94 of 424 crops sown to susceptible hybrids
- All genetically resistant canola products still fully effective in 2011
  - Disease severity on resistant canola crops was low (0.2 – 10.2%)
  - Severe clubroot found in many of the canola crops sown to susceptible cultivars (severity >60% in some)

Clubroot Situation (Fall 2011)

- 831fields with confirmed *P. brassicae* infestations
- Mostly in central Alberta
  - Few cases in southern Alberta and Saskatchewan
  - A few infected plants in experimental plots in Elm Creek, MB (2005)

Strelkov et al. 2012

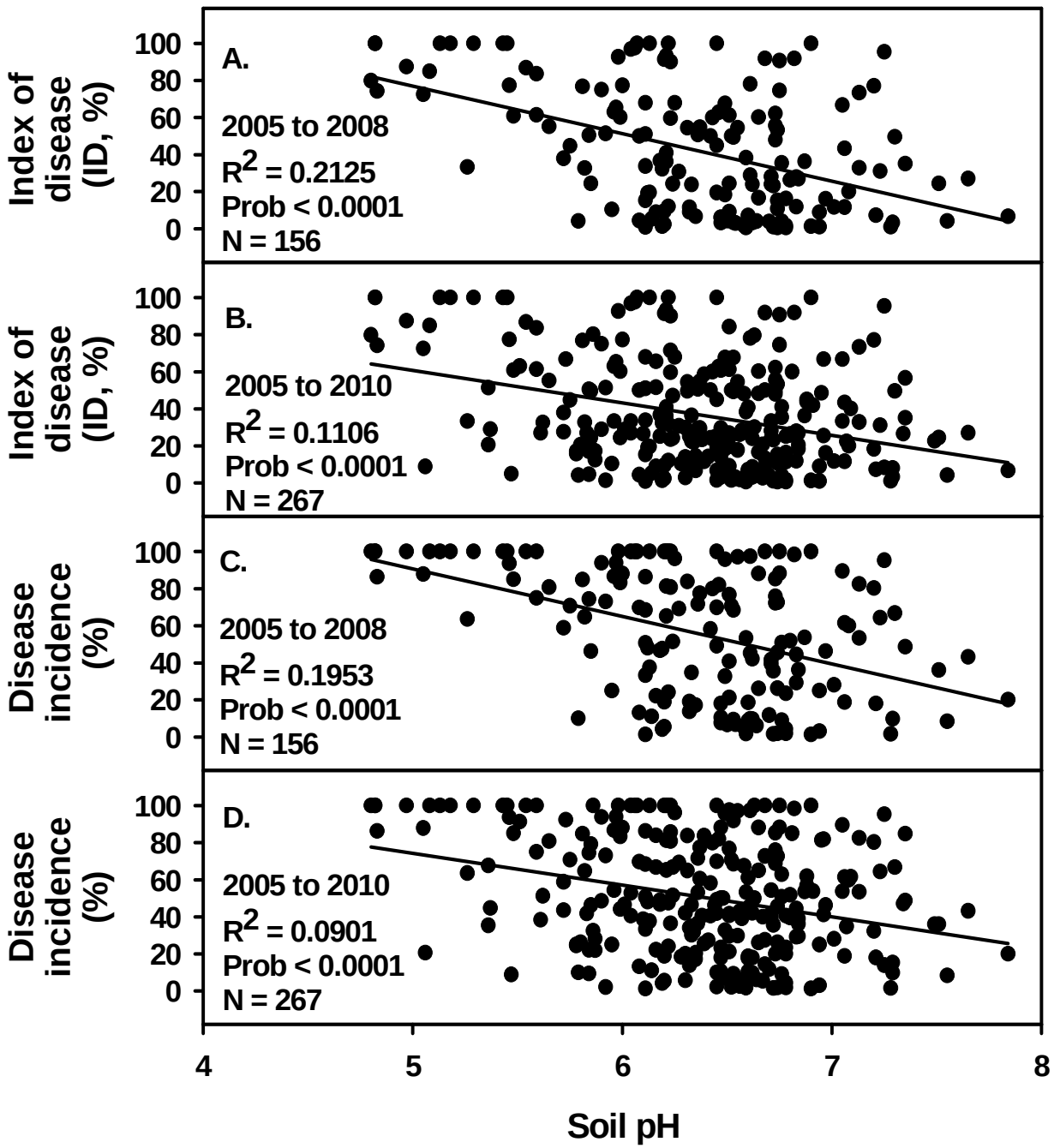


Characteristics of Infested Fields

Compared clubroot severity & soil pH in 267 canola crops found to be clubroot positive between 2005-2010

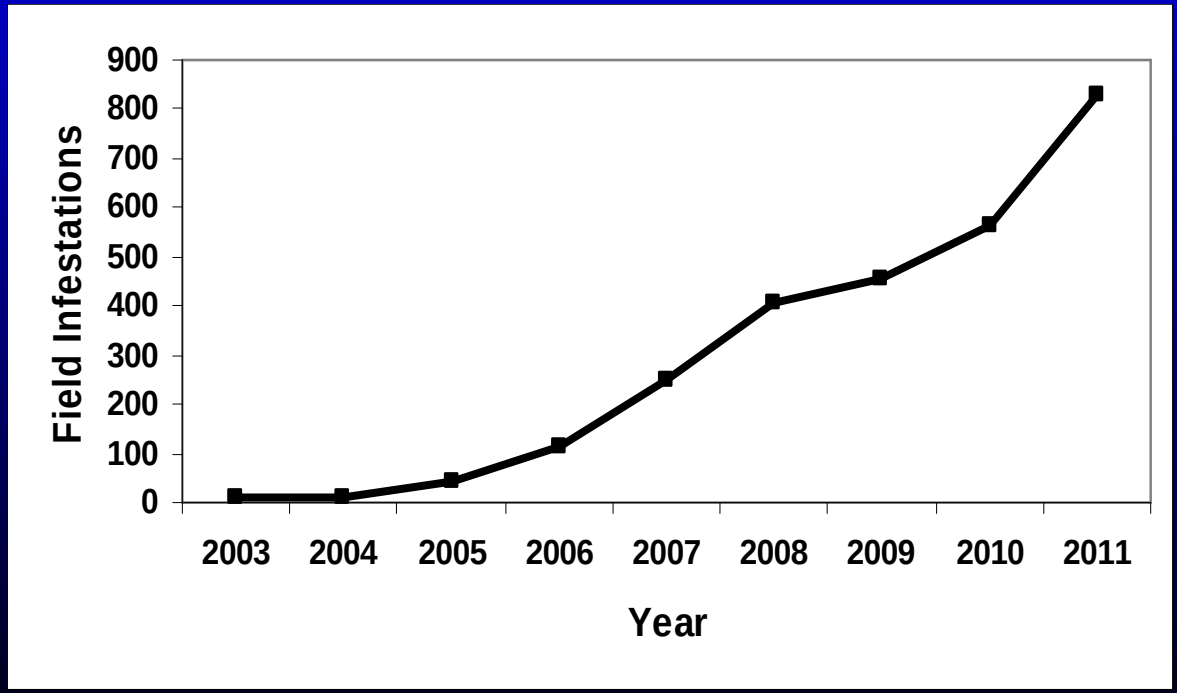
While pH contributes to clubroot symptom severity, other factors appear to be involved

Cao et al.



Clubroot in Alberta

- **Record number of new cases in 2011**
  - **Favorable conditions early in the growing season**
  - **Continued spread of the disease**



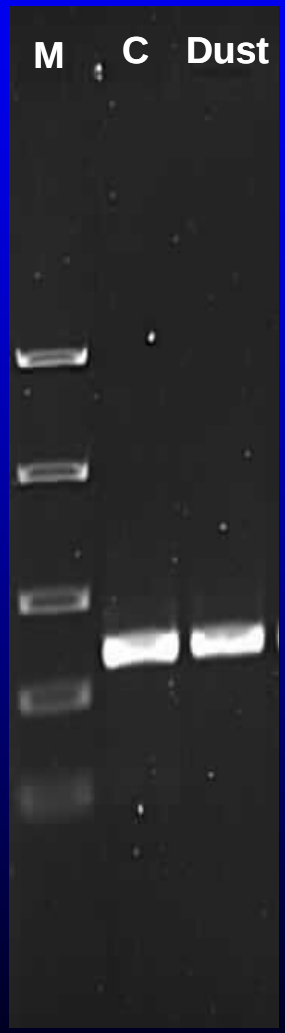
Clubroot Dispersal

- Main culprit is soil movement on machinery (Cao et al. 2009)
- Common, untreated seeds & tubers from infested fields may also serve as minor mechanism (Rennie et al. 2011)
- What about dispersal in dust and water?

Dispersal in Dust & Water

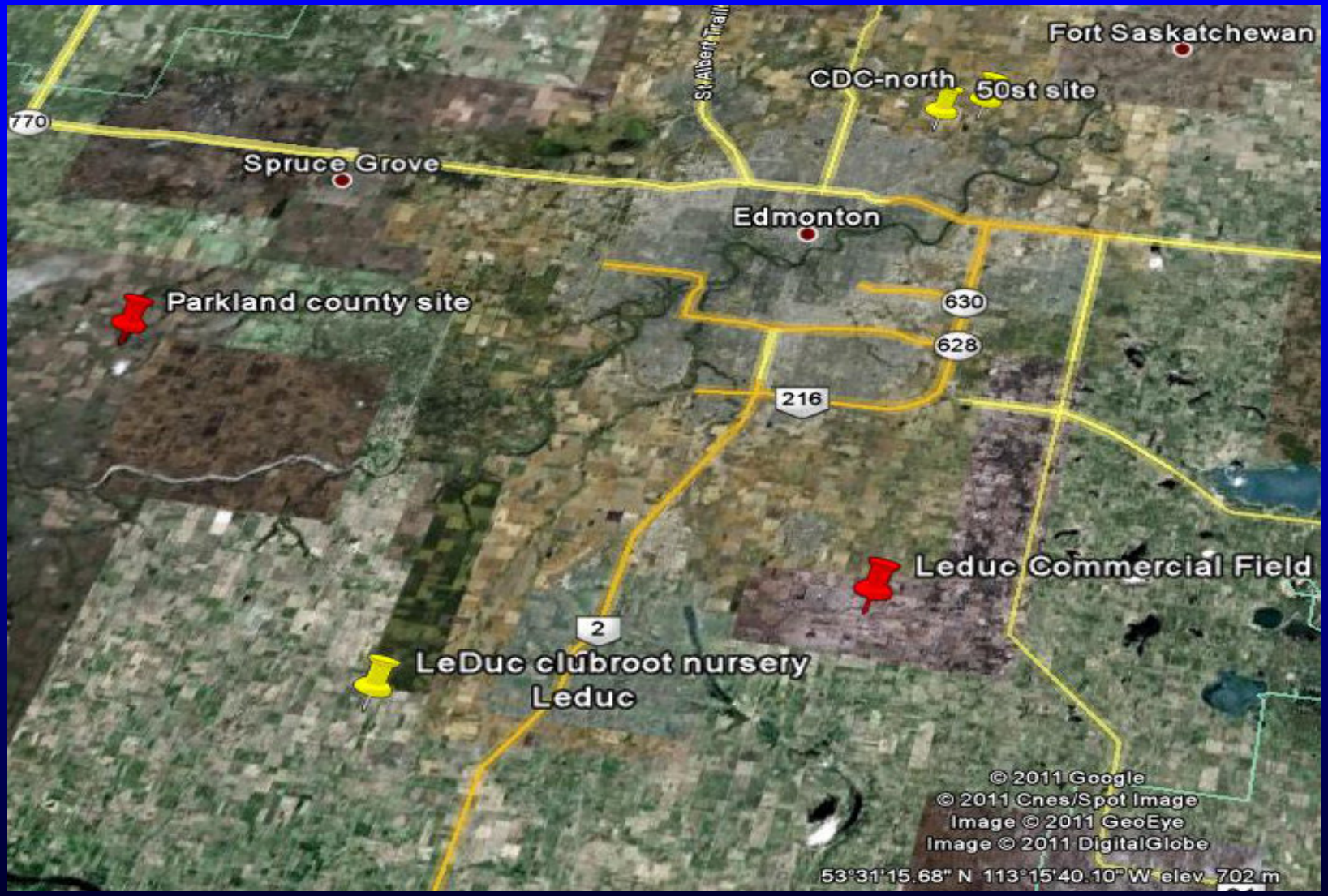
- Clubroot dispersal in dust and water may also occur
  - Extent of problem not well defined
- Epidemiological studies to track and quantify spread

Conventional PCR

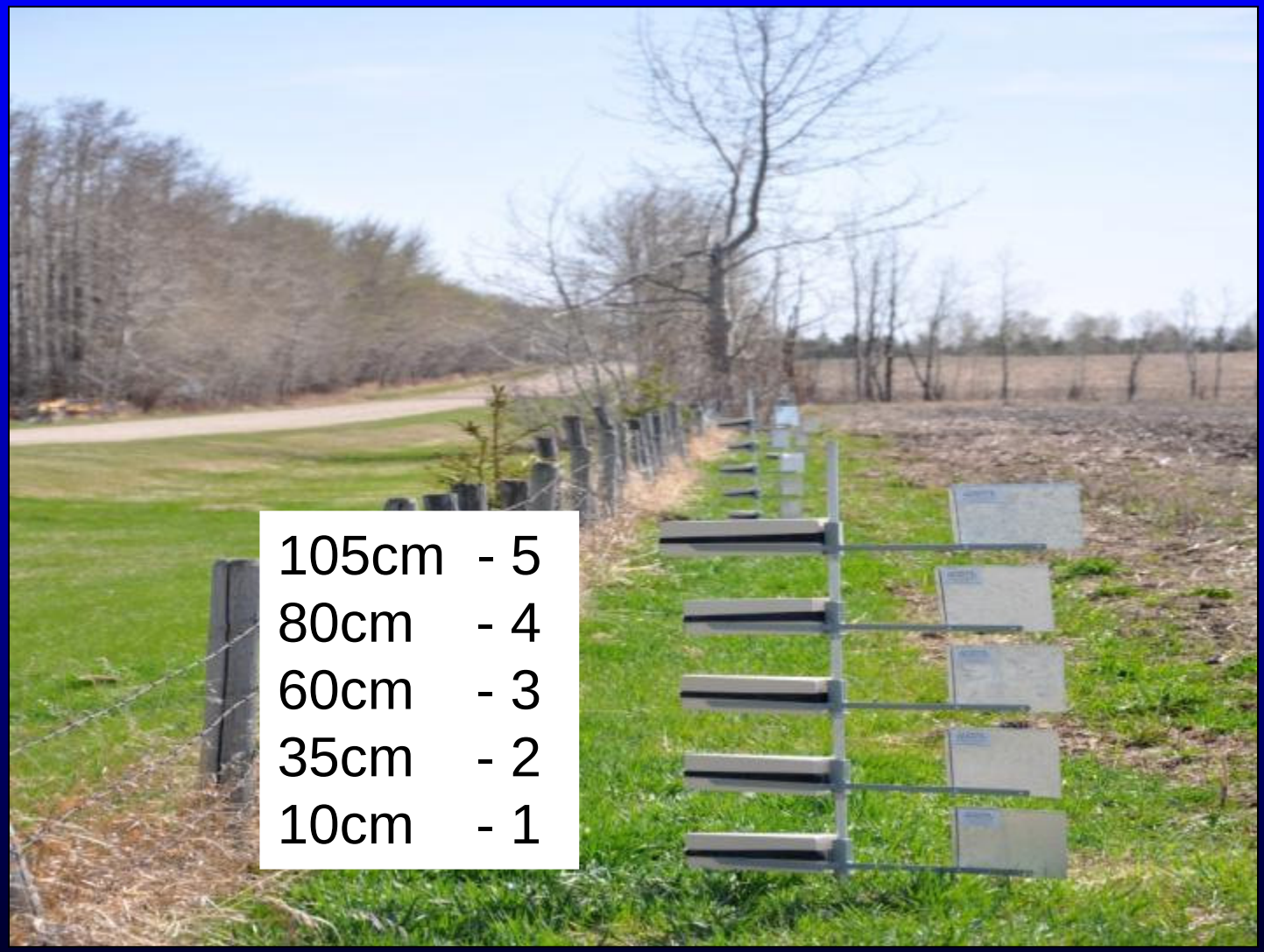


Rennie et al.

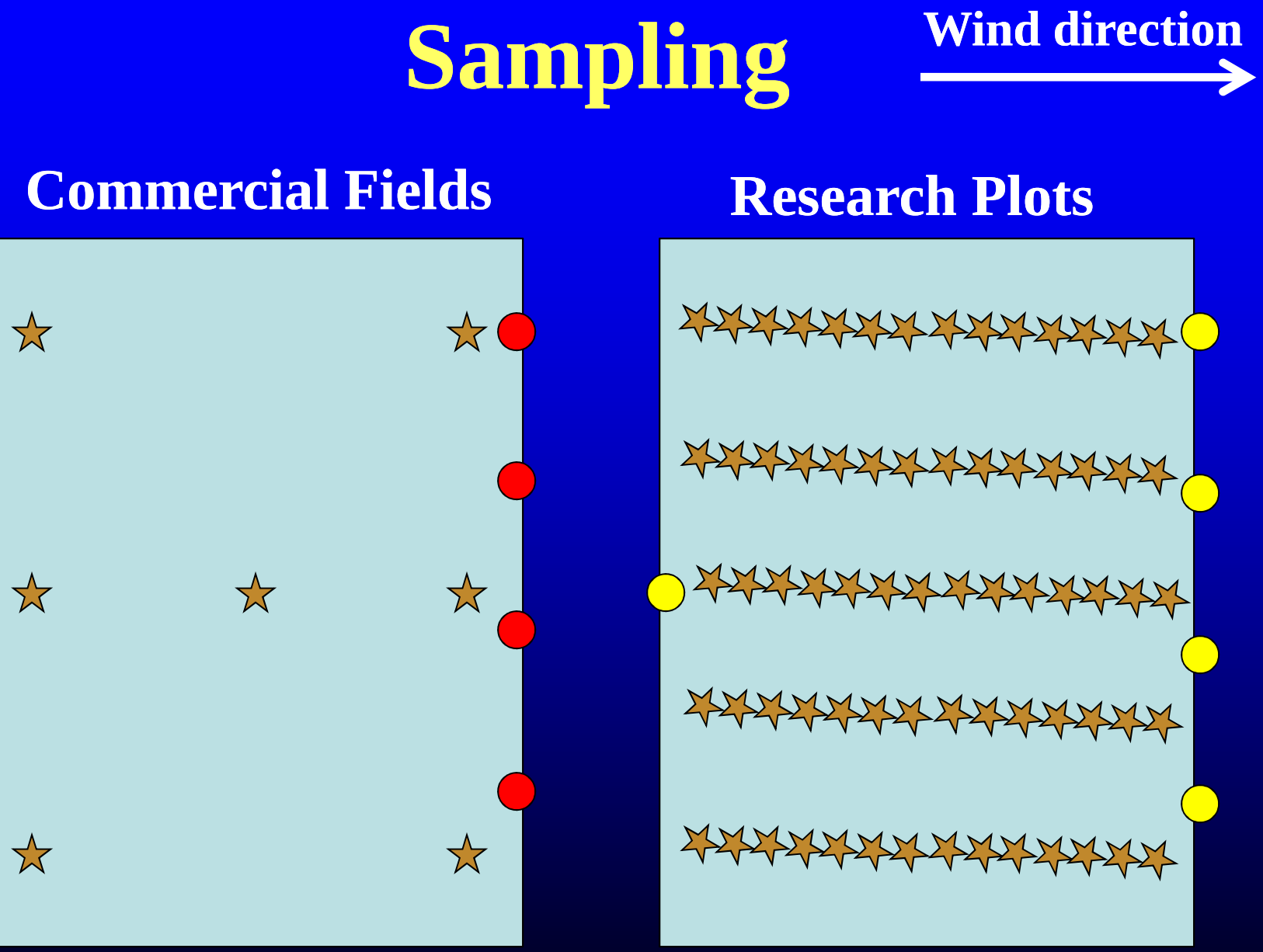
Research Sites

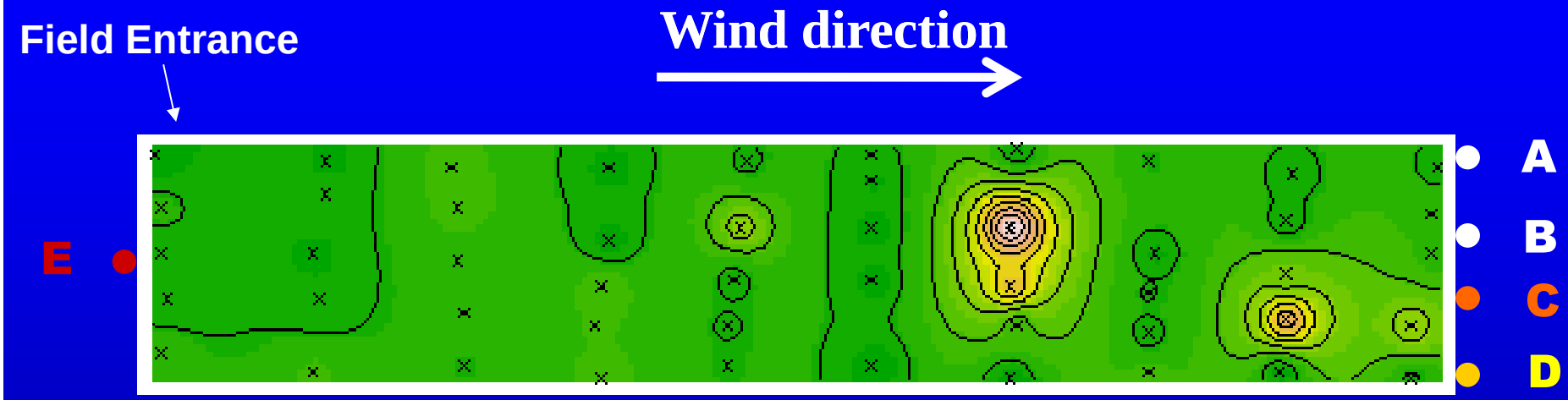


BSNE (Dust) Samplers



Sampling

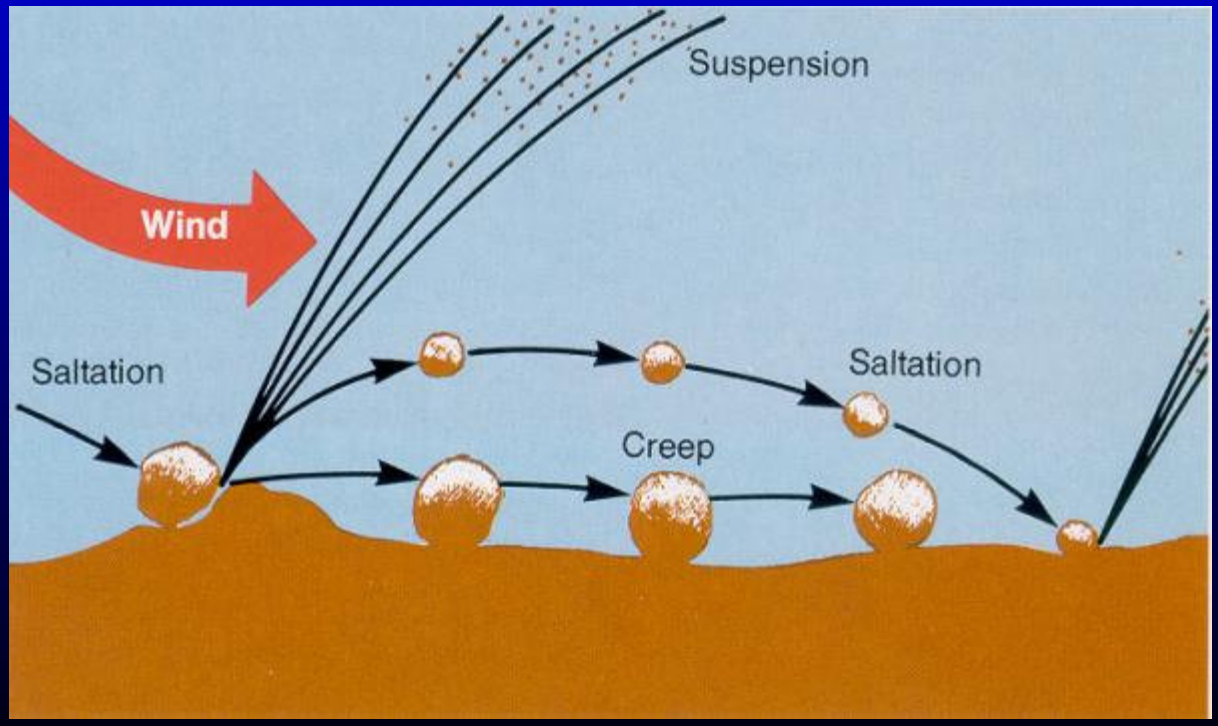




Sampler	Concentration of spores in dust	Amount of dust collected
A, B	No spores detected at any height	
D (10 cm)	7.7×10^2 spores per g	3.16 g
D (105 cm)	8.8×10^2 spores per g	0.370 g
C (10 cm)	1.7×10^3 spores per g	2.33 g
E (80 cm)	1.6×10^4 spores per g	0.260 g

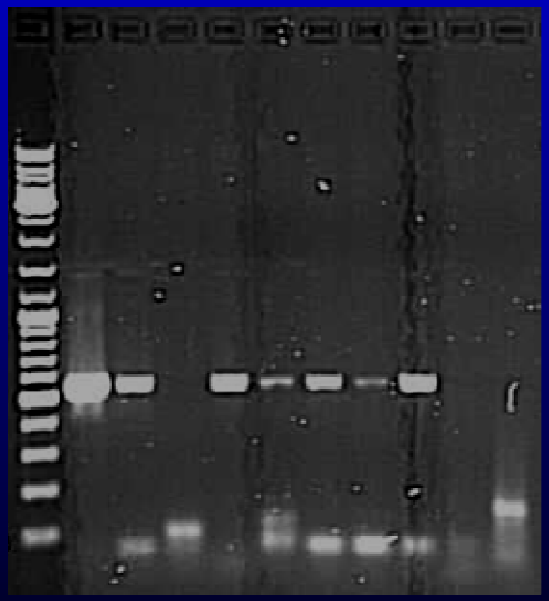
Dispersal in Soil and Water

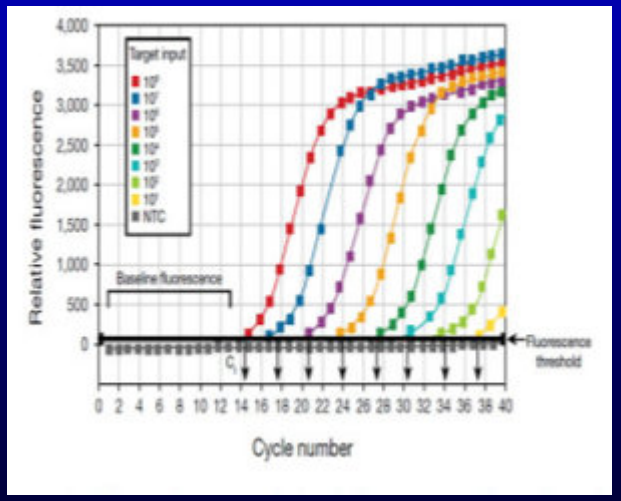
- Work ongoing in 2012 at multiple sites
  - Dust and water run-off
- Will also examine surface creep



Additional Surveillance Activities

- **Also screening hundreds of soil samples collected from SK and MB for presence of *P. brassicae***





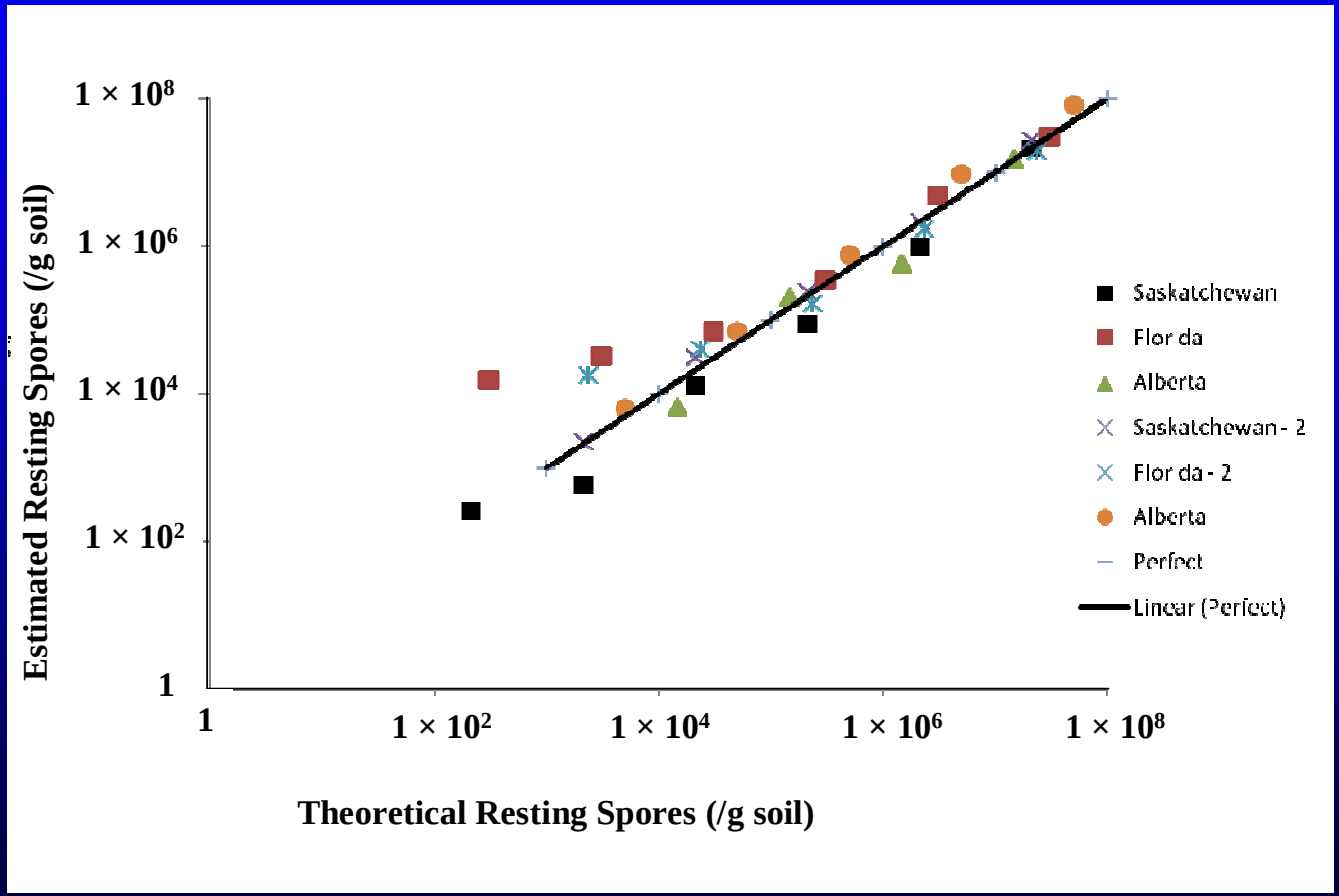
(1) Conventional PCR ⟶ (2) Quantitative PCR ⟶ (3) Bioassays

Improved Clubroot Detection and Quantification

- Clubroot research facilitated by development of improved methods for pathogen detection and quantification
- Conventional PCR (Cao et al. 2007)
  - Soil and plant tissue
- Quantitative PCR (qPCR)
  - Seeds and tubers (Rennie et al. 2011)
  - Soil (Rennie et al.)
  - Root tissue (Cao et al.)

qPCR Assay to Measure Spores in Soil

- Robust technique
- Adapted from our protocol for seeds
- Multiple soil types and pathogen strains



In Planta Quantification of *P. brassicae*

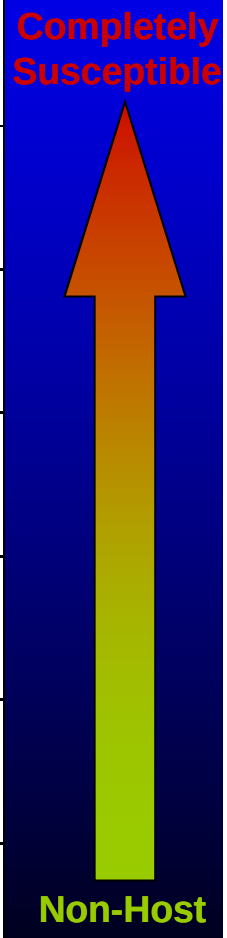
- **Methodology also developed for quantification of *P. brassicae* in roots of plants**
- **Will not only facilitate biological studies, but also has potential to be used as a resistance screening tool**

qPCR for Resistance Screening

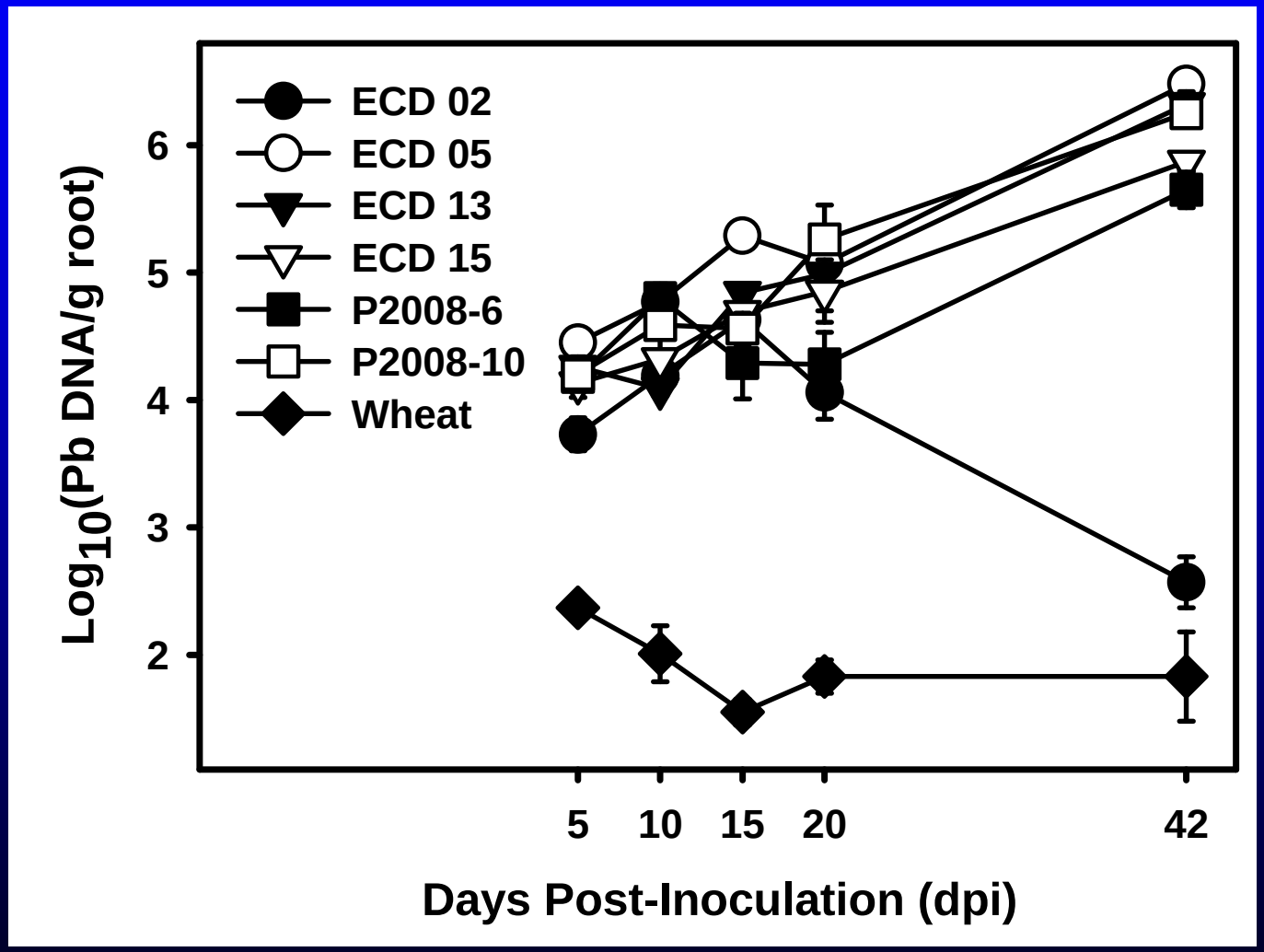
- **If amount of *P. brassicae* DNA in plant roots shortly after inoculation is well-correlated with eventual clubroot reaction, qPCR could be used to screen out material that will likely be susceptible**

Plant Material

Plant Genotype	Abbreviation	Clubroot reaction ID ± S.E. (%)
B. rapa var. *pekinensis* cv. Granaat (Chinese cabbage)	ECD 05	99.1 ± 0.9
B. oleracea var. *capitata* cv. Jersey Queen (Cabbage)	ECD 13	81.5 ± 3.1
B. oleracea var. *capitata* subvar. *laciniata* cv. 'Verheul' (Kale)	ECD 15	37.6 ± 5.6
B. napus L. line P2008-10 (Canola line)	P2008-10	29.6 ± 2.9
B. napus L. Line P2008-6 (Canola line)	P2008-6	13.0 ± 4.0
Brassica rapa subsp. *rapifera* line AAbbCC (Polish rape)	ECD 02	0.0 ± 0.0
Triticum aestivum L. cv. Harvest (Wheat)	Wheat	0.0 ± 0.0



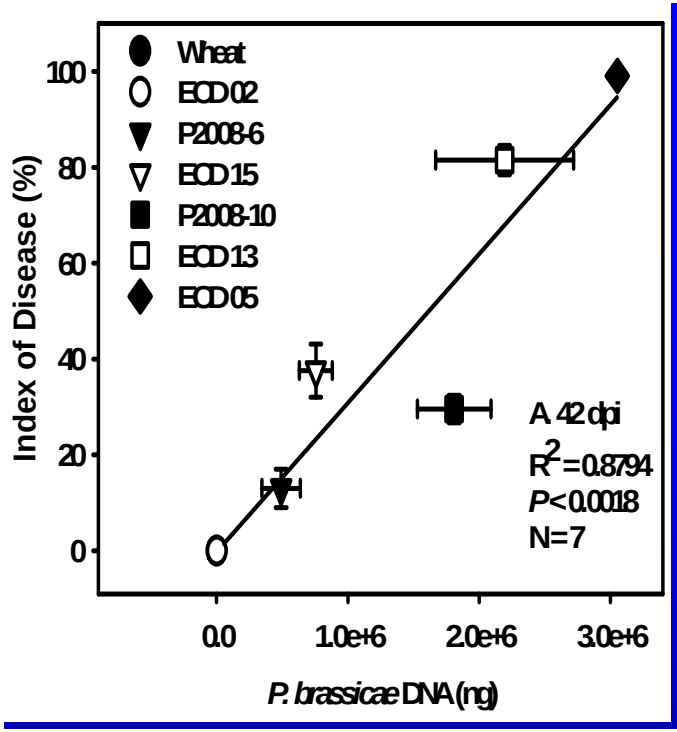
Amount of *P. brassicae* DNA in Roots

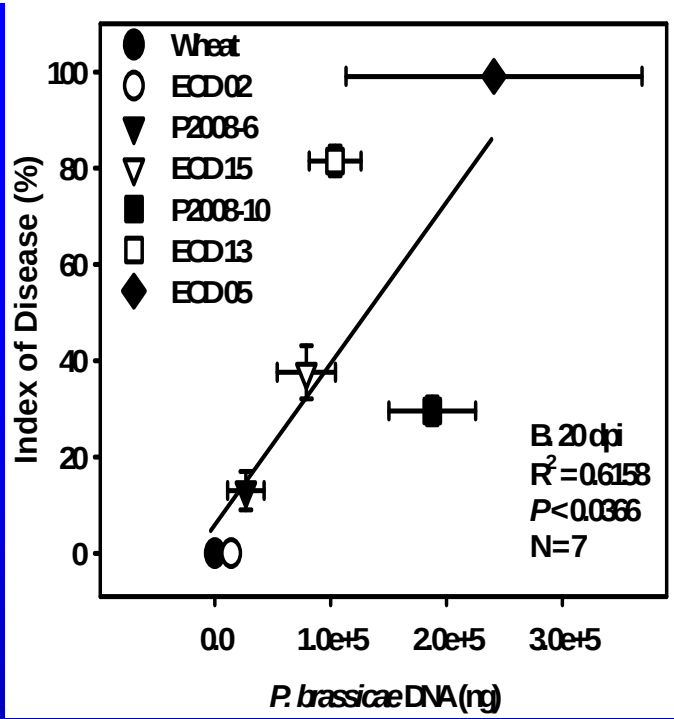


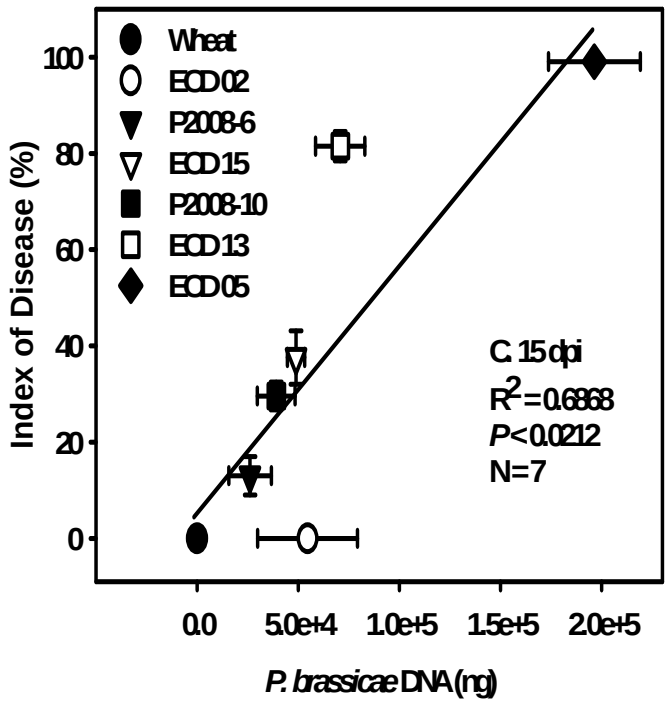
Completely Susceptible

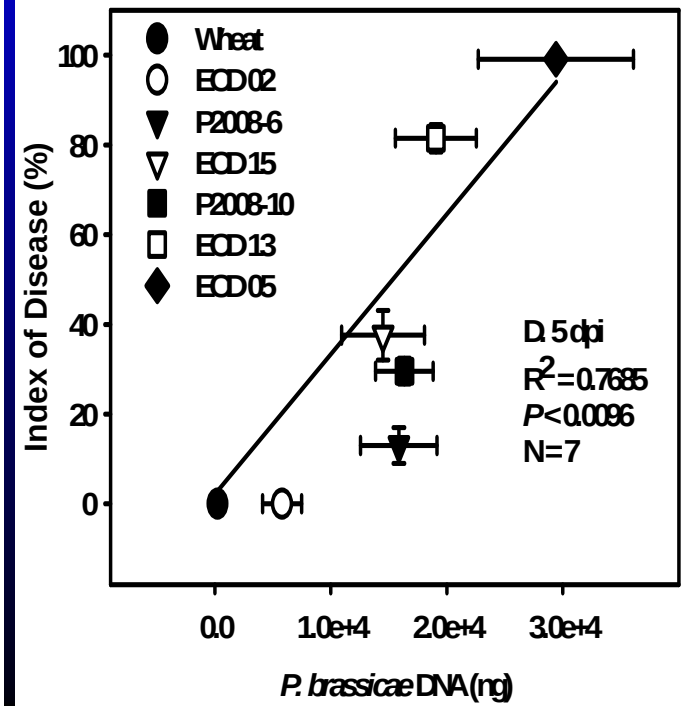
Non-Host

Cao et al.









- **Good correlations between clubroot severity at 42 days, and amount of pathogen DNA at 5, 15, 20 and 42 dpi**
- **Amount of DNA as early as 5 dpi could be used as predictor of eventual clubroot response**

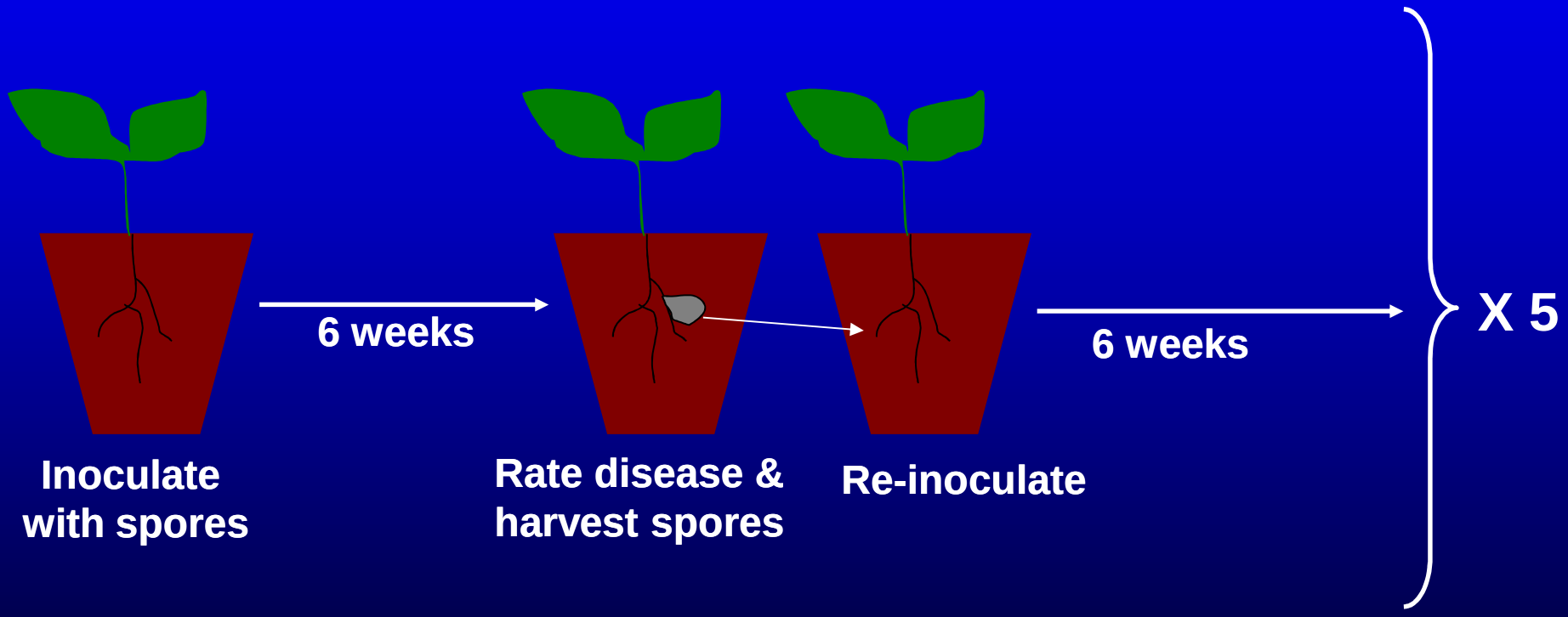
Clubroot Resistance Stewardship

- **Genetic resistance holding up well as of 2011, but will have to be well-managed!**
- **Conducting series of studies looking at adaptive potential of *P. brassicae***

Pathogen Cycling Experiment

- **Objective:** To assess the effect of multiple infection cycles on the virulence of *P. brassicae*
- **Methodology:**
  - Population and single-spore isolate representing pathotype 3
  - Cycled 5× on a selection of R, MR and S host genotypes

Methodology



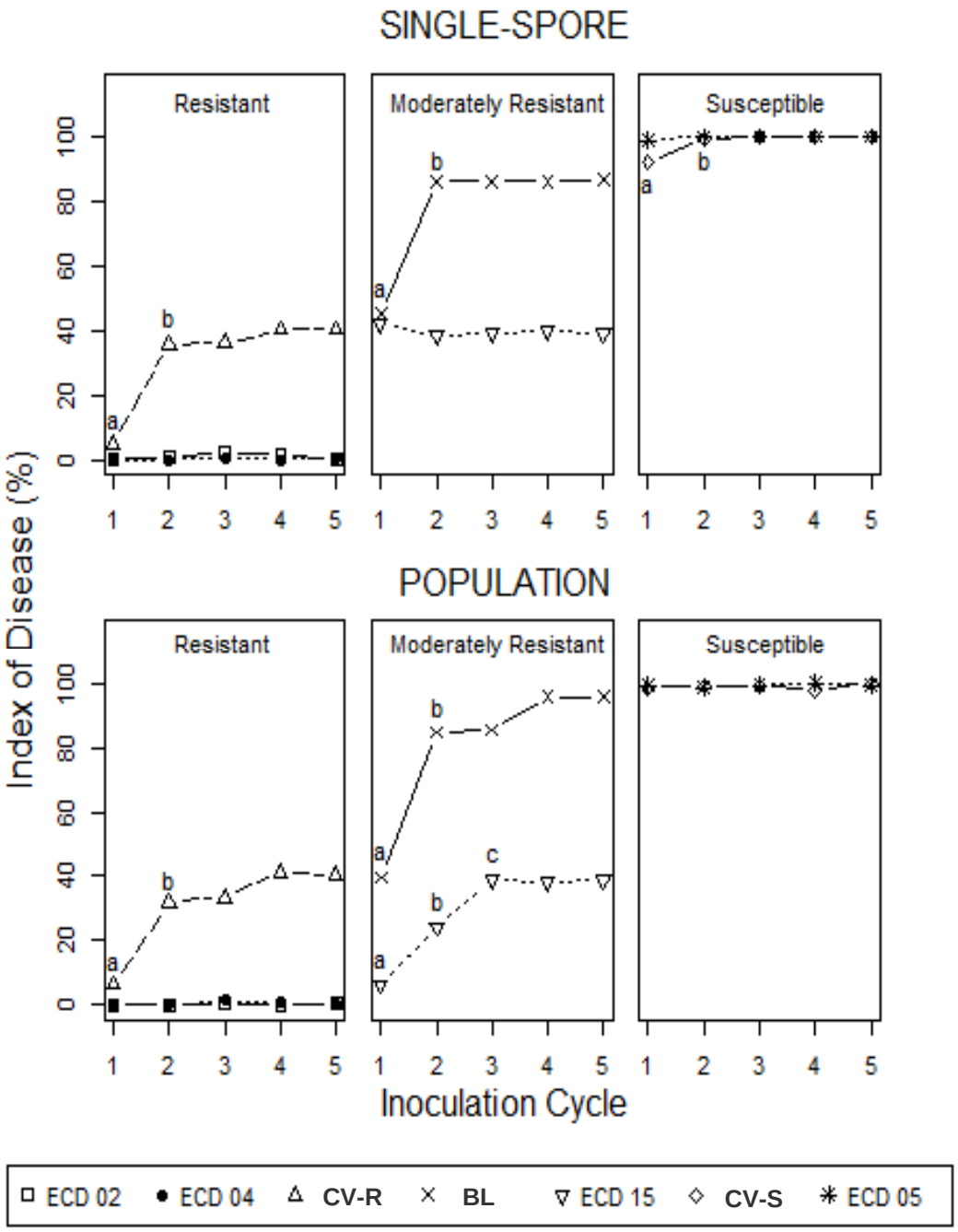
GREENHOUSE STUDY

Pathogen Cycling

Repeated cropping of a resistance source can erode the effectiveness of that resistance

Resistance stewardship is important!

LeBoldus et al. 2012



Cross-Infectivity Experiments

- **Objective:** To assess whether various commercial canola cultivars carry the same or different sources of resistance
- **Methodology:**
  - Cross-inoculate canola cultivars with *P. brassicae* populations cycled on other *Brassica* hosts
- **Rationale:**
  - If same source of resistance, then pathogen populations cycled on one cultivar should show increased infectivity on other cultivars

Cross-Infectivity Experiments

Pathogen populations cycled on one host did not show equivalent increases in virulence on other hosts

Canola host	Cycled populations			
	CV-R	**BL**	**ECD 05**	**ECD 15**
W	5.5±9.4	1.9±7.7	4.6±8.9	5.5±9.4
X	8.6±2.9	0.0±0.0	0.0±0.0	0.0±0.0
Y	1.9±7.7	0.0±0.0	0.0±0.0	0.0±0.0
Z	11.1±9.5	0.0±0.0	0.0±0.0	0.0±0.0

LeBoldus et al. 2012

Rotation of Resistance Sources

- Cross-infectivity experiments suggest that some cultivars may be carrying different sources of resistance
- Potential for rotation of resistance sources?
- Further work is ongoing

Other Activities

- **A wide breadth of other research is also currently underway**
  - **Clubroot and soil foraging by roots**
  - **Resting spore survival in dust**
  - **Molecular diversity of pathogen populations, markers for strain differentiation**
  - **Histopathology & host-pathogen interactions**
  - **Development of a Canadian Clubroot Differential system… *discussion later today!***

Summary

- **Extensive research under the Pathology Pillar**
- **Focused on various streams: pathogen surveillance and dispersal, development of improved clubroot quantification tools, resistance stewardship & other areas**

- ***Striving to meet the aim of improved understanding of the pathogen & resistance mechanisms, disease surveillance, pathotype monitoring & detection/diagnosis***

Acknowledgments

- **Collaborators**
- **Students & other research personnel**
- **Funders: Canola Council of Canada through AAFC Clubroot Risk Mitigation Initiative, Alberta Crop Industry Development Fund, Alberta Innovates – Bio Solutions, ACPC, Canadian Seed Growers Association, SaskCanola, MCGA and other industry partners**