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Biology Pillar, CRMI

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Clubroot Summit, March 7, 2012

Canada

Pillars

- Breeding
- Disease management
- Surveillance
- **Biology/Pathology**
  - Effect of temperature, pH, and moisture
  - Effect of B and soil type
  - Expression and timing of resistance
  - Model crops and differential reaction
  - Other (satellite imagery, inducers, RNAi, etc.)

Research Team

Bruce Gossen and Gary Peng – AAFC, Saskatoon

Mary Ruth McDonald – University of Guelph

- A. Deora, K. Sharma (post-docs)
- K.K.C. Adhikari (MSc, graduated)
- H. Kasinathan, T. Gludovacz (MSc students)

Sheau-Fang Hwang – AARD, Edmonton

Stephen Strelkov – U of A, Edmonton

Denis Pageau – AAFC, Normandin

Fran Walley – U of S, Saskatoon

Anne Smith – AAFC, Lethbridge

Impact of Temperature

- Examine the impact of temperature and seeding date on clubroot severity on canola and vegetable Brassicas.
- Determine if pak choy is a good model system for clubroot reaction on canola.

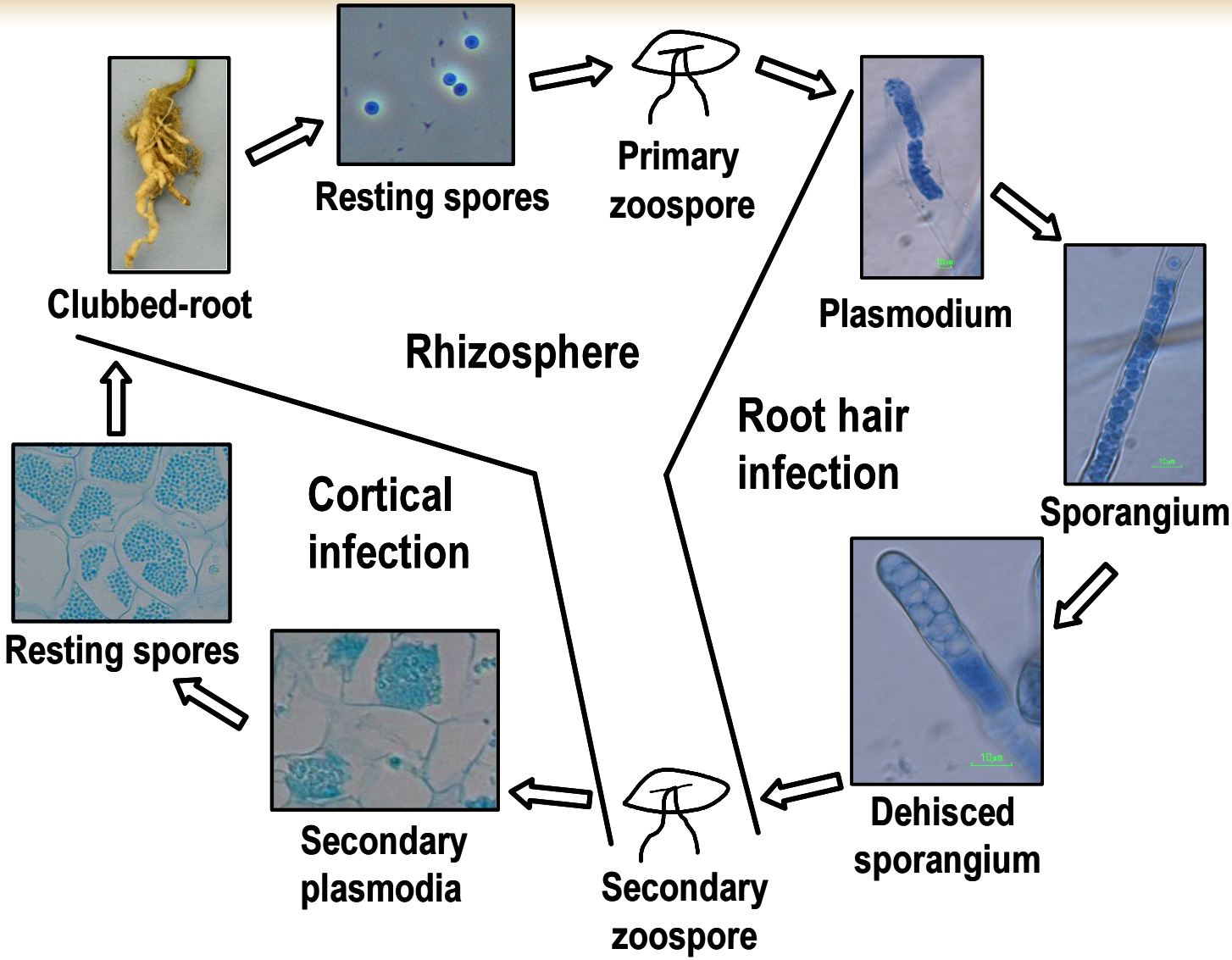
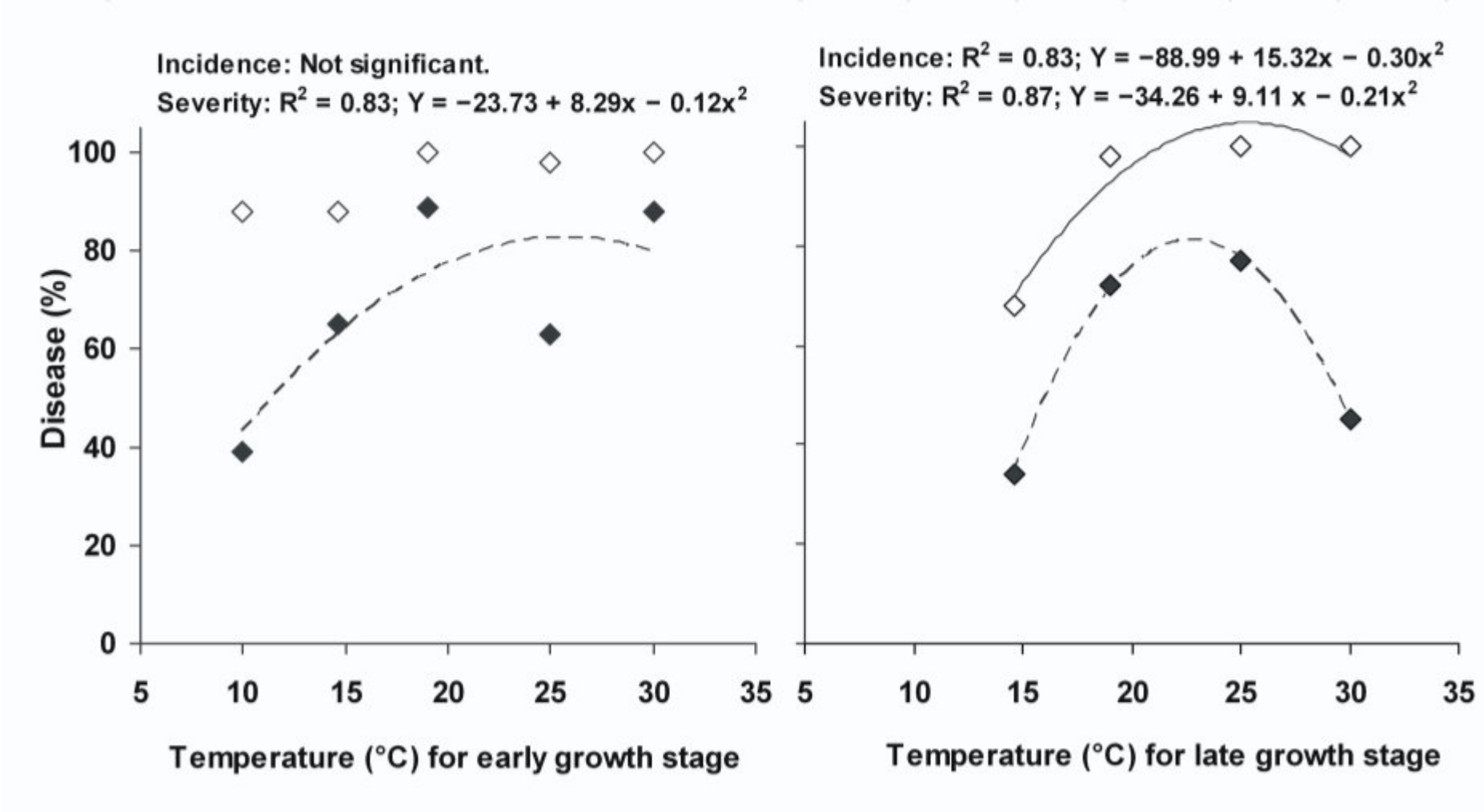
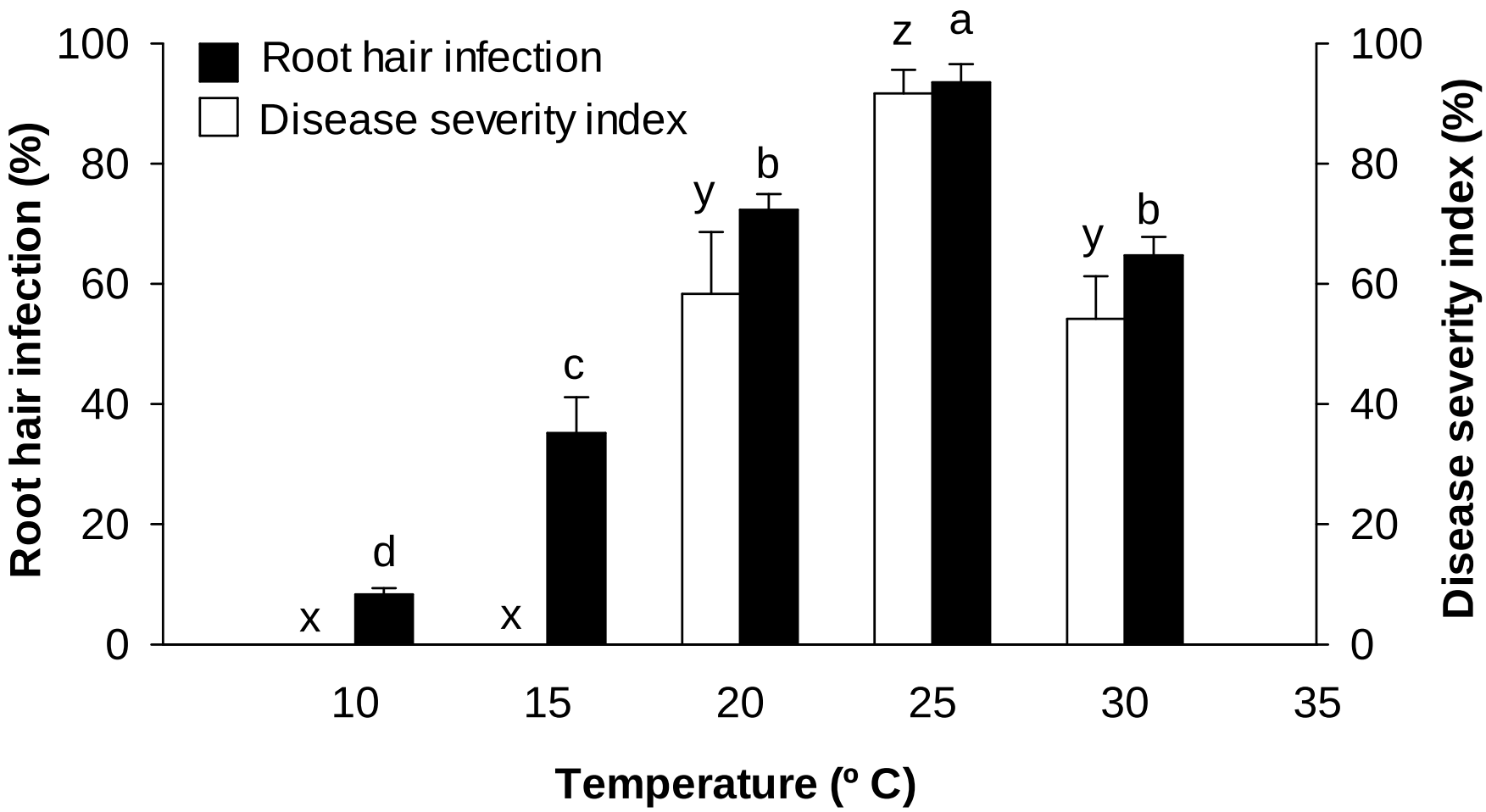


Fig. 1. Life cycle of *Plasmodiophora brassicae.*

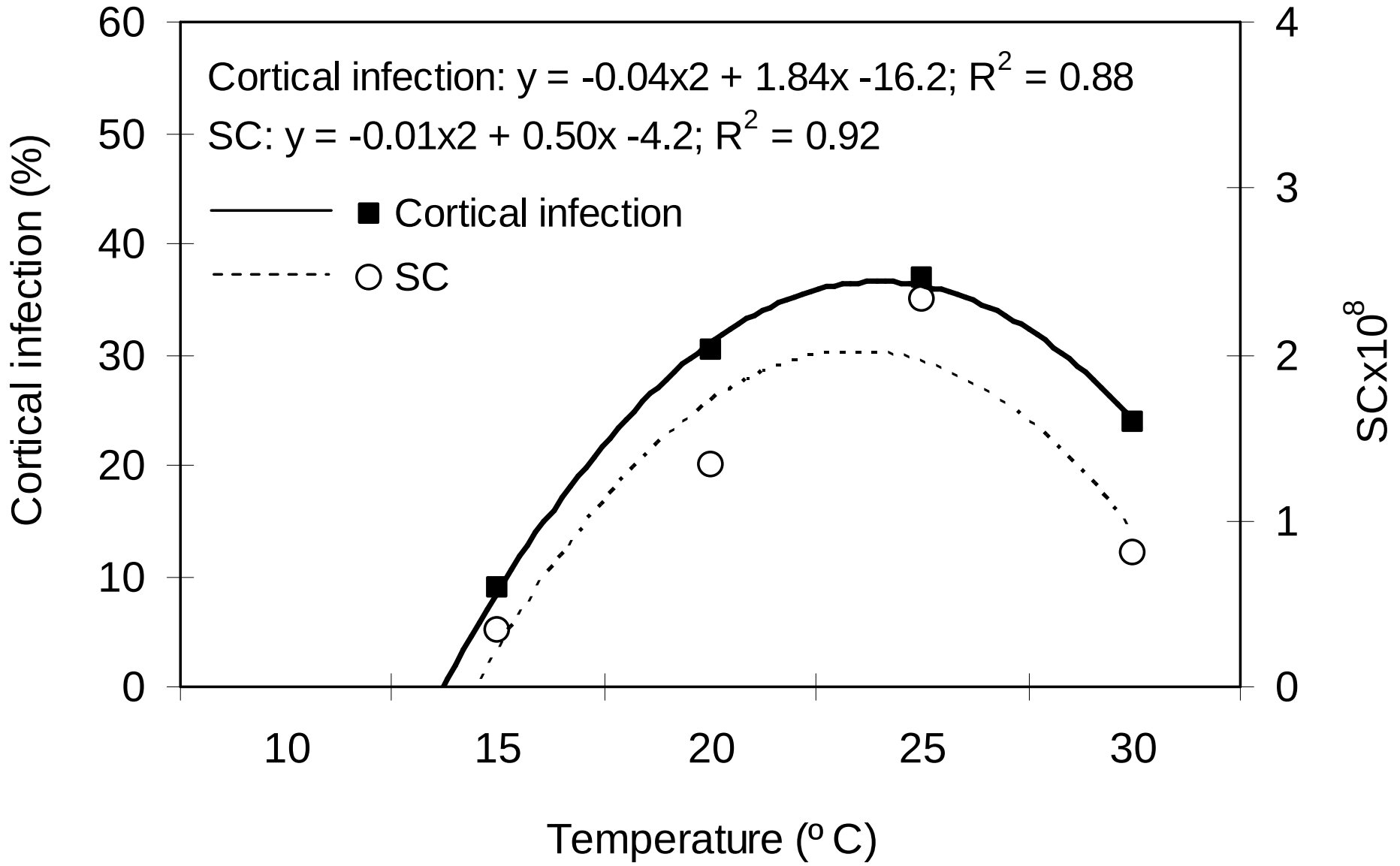
Clubroot Incidence and Severity



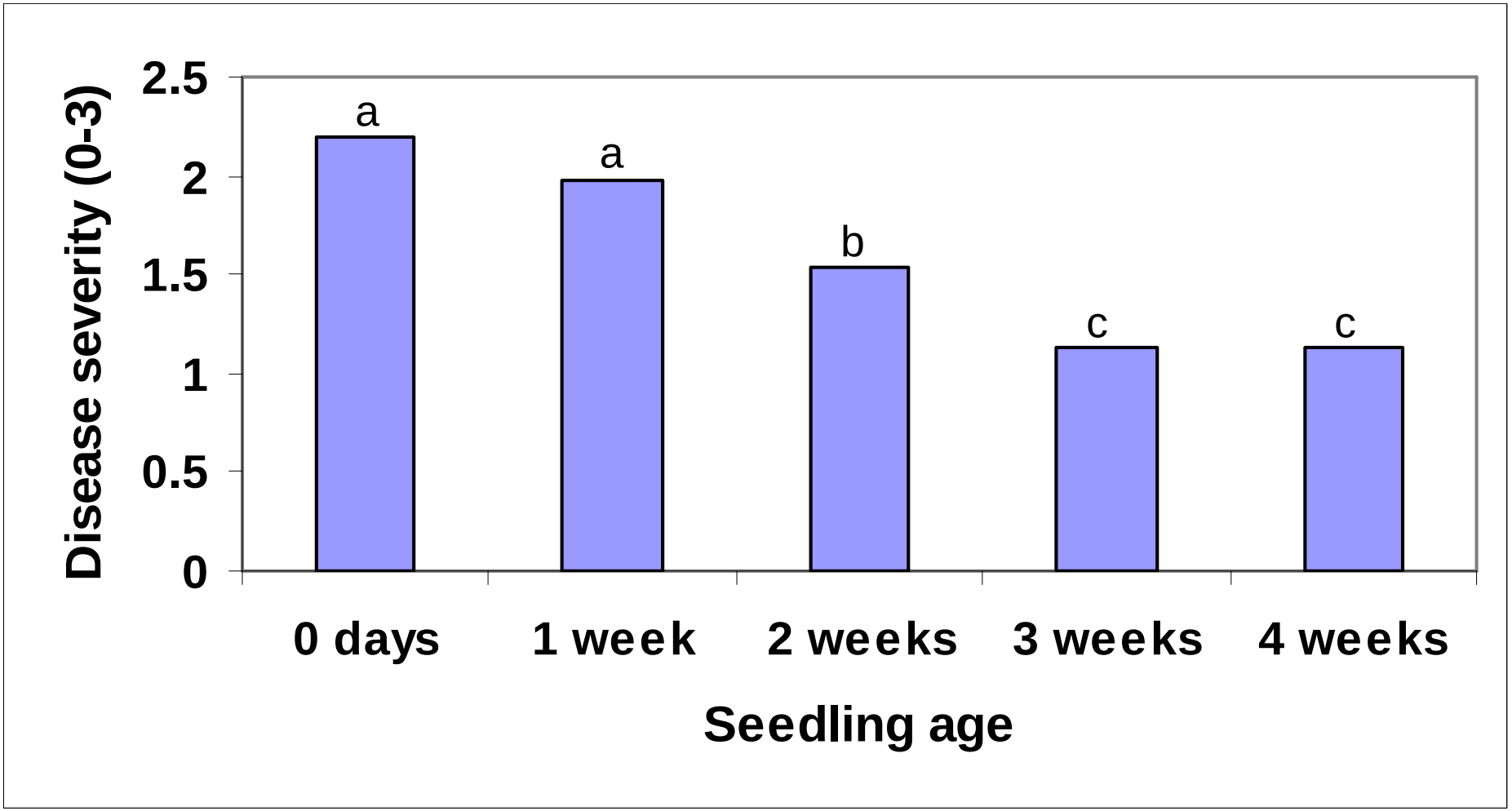
Correlation: Root Hair Infection vs. Severity



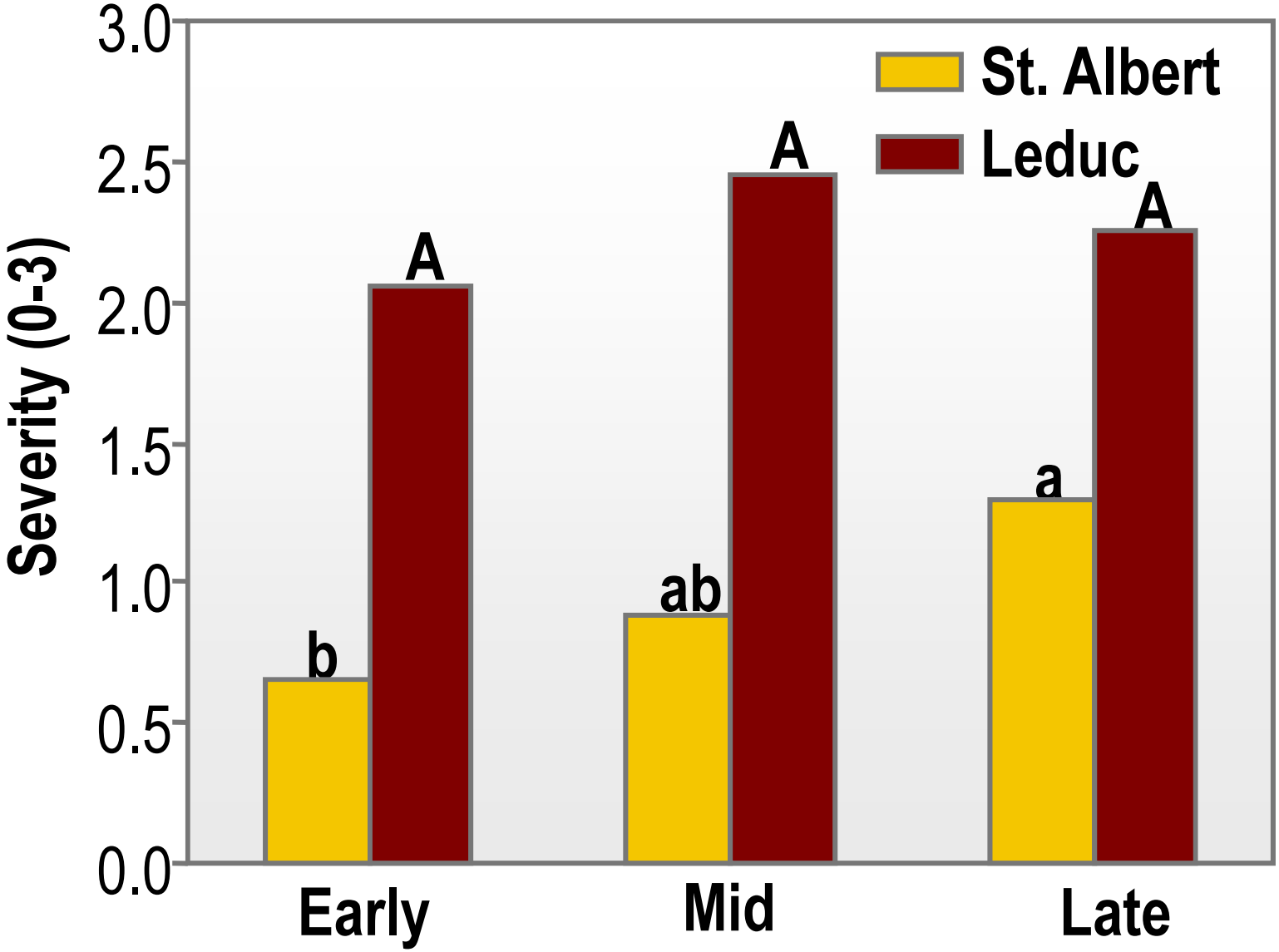
Cortical Infection & Spore Production



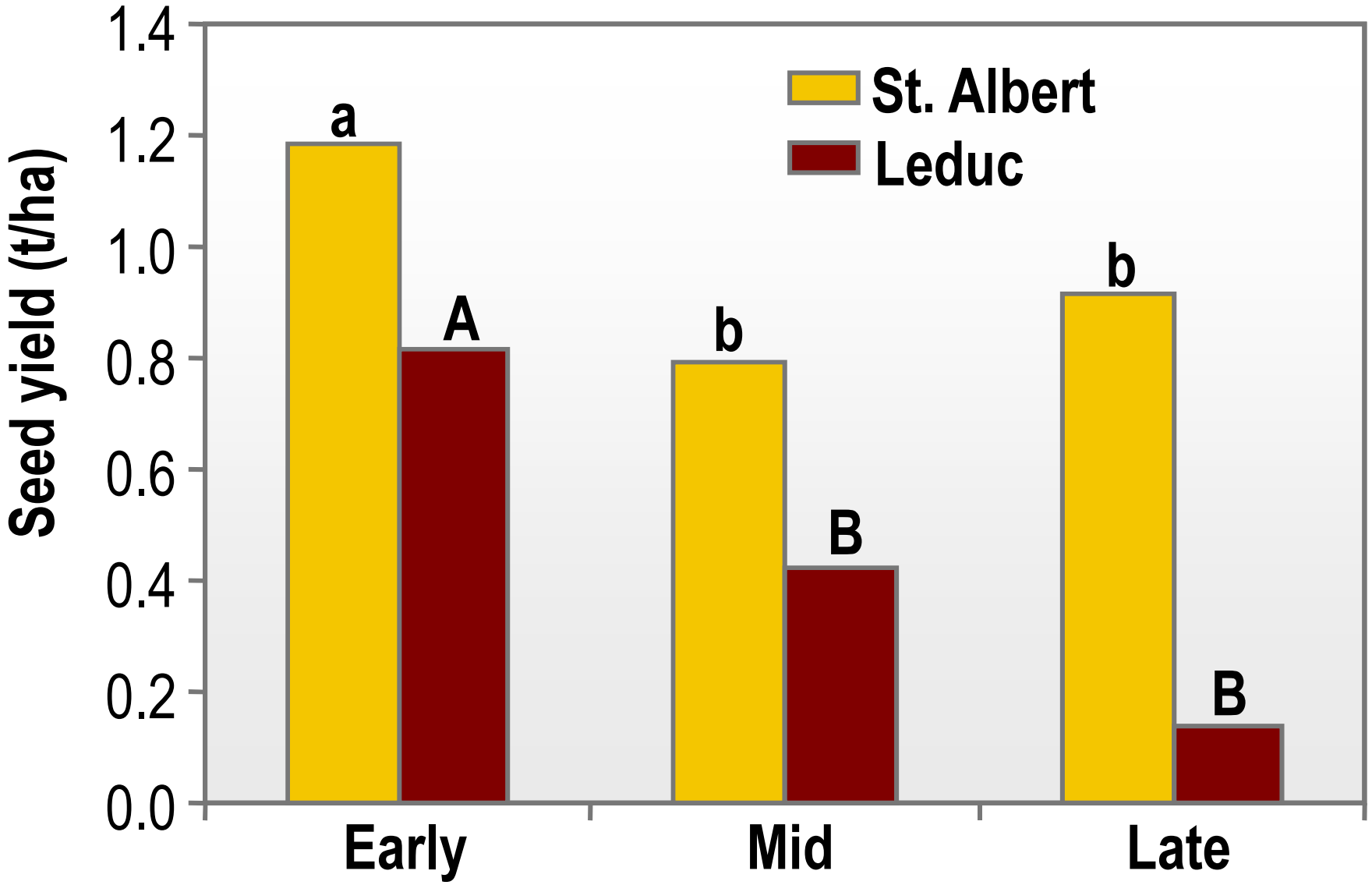
Effect of Seedling Age on Severity



Impact of Seeding Date on Canola



Impact of Seeding Date on Canola

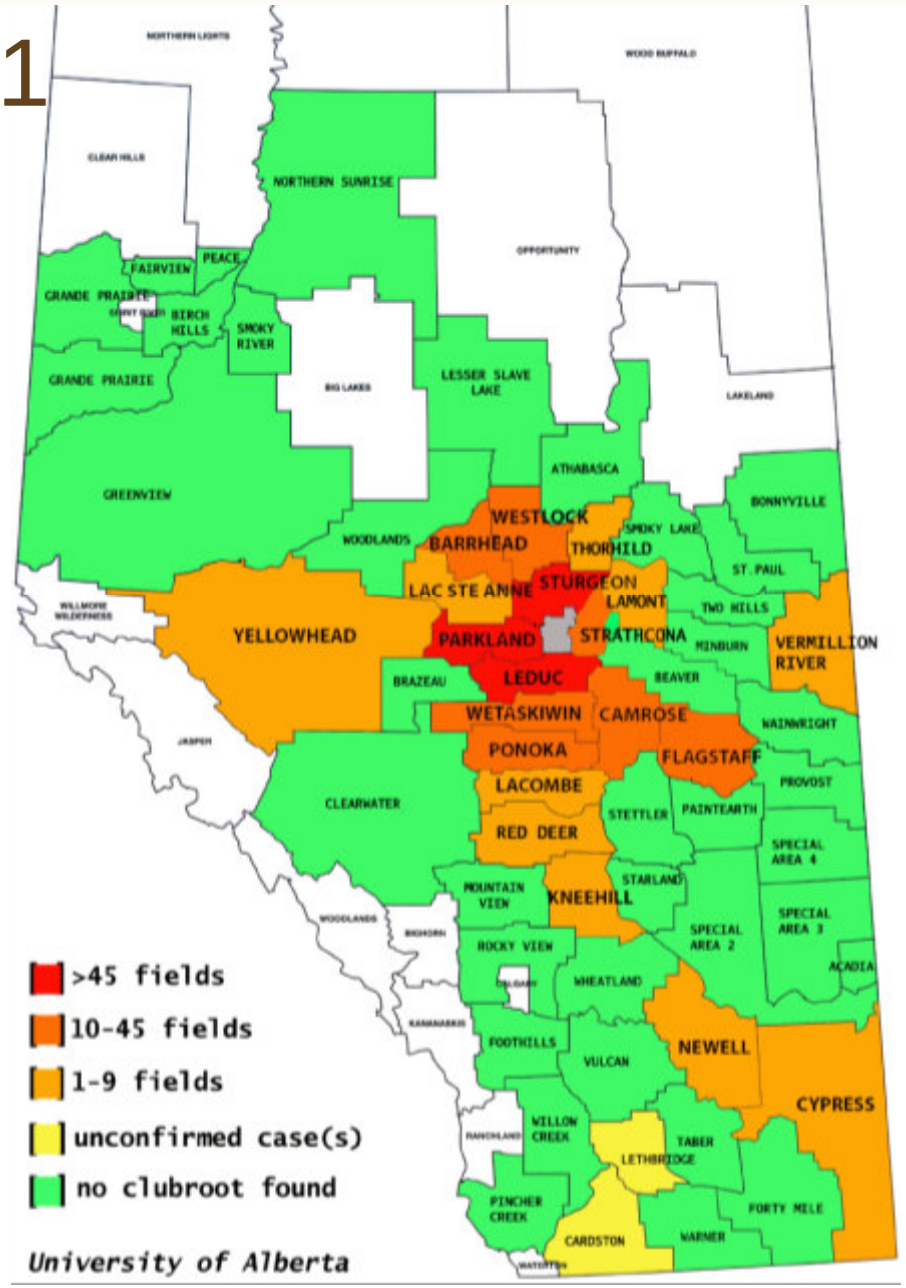


Conclusions

- Low temperatures (≤ 17º C) reduce clubroot development and severity.
- Early seeding reduced clubroot severity and increased seed yield of canola.
- Impact was small relative to resistance.
- Shanghai pak choy would make a good model system for temperature studies.

Clubroot status, 2011

- Clubroot confirmed in >800 fields in Alberta
- Most severe in black soil zone of central AB, on heavy, acidic soils with abundant rainfall
- Confirmed (2 fields) in Saskatchewan in 2011
- **Crucial question** - What is the clubroot risk for other areas, e.g., on more alkaline or lighter soils with lower rainfall?



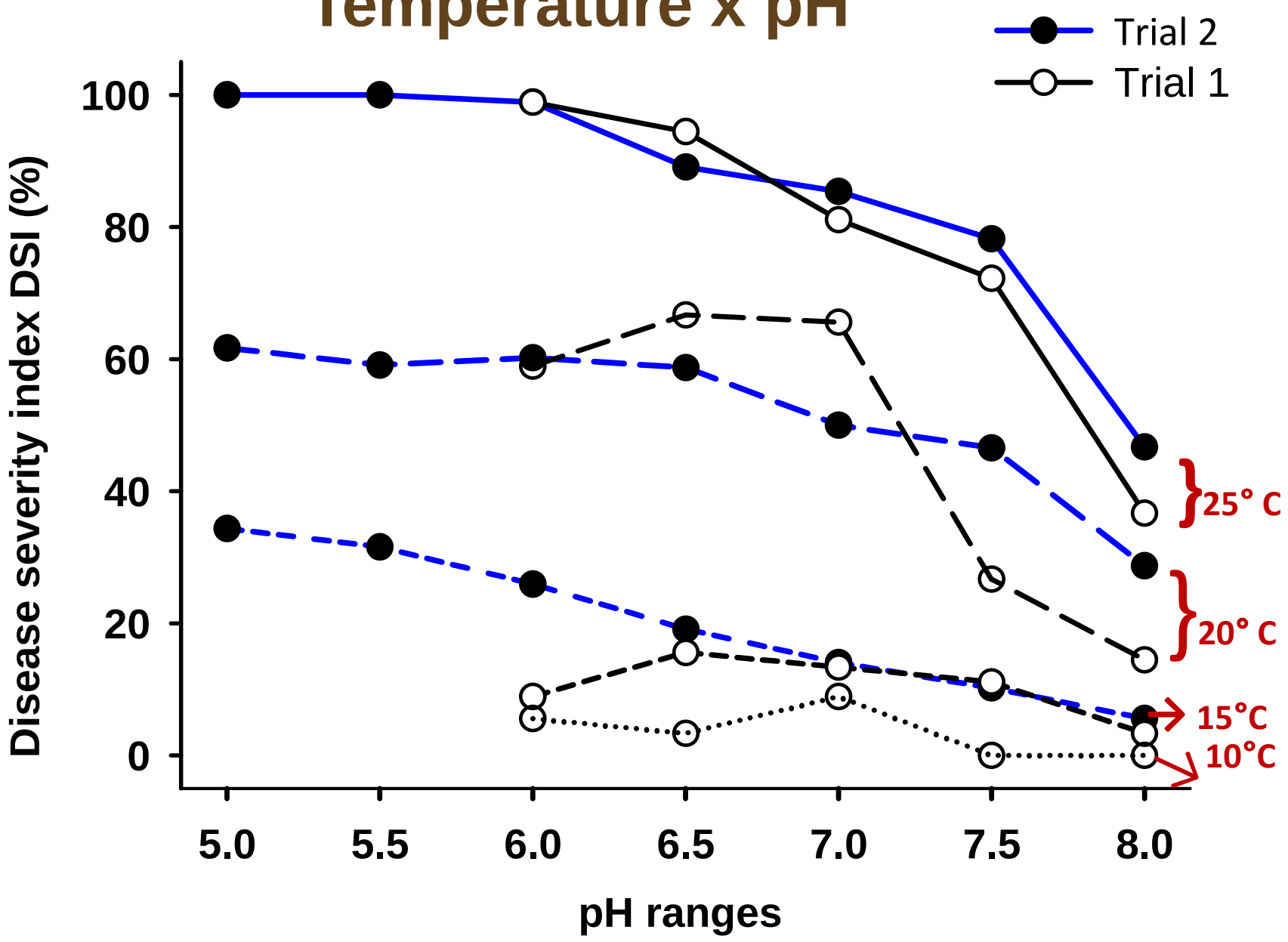
Projects to Assess Clubroot Risk

- ❑ *Turkington / Klein-Gebbinck* – using projection (Climex) and modeling (Dymex) approaches to predict clubroot risk.
  - Very little data available for canola (!)

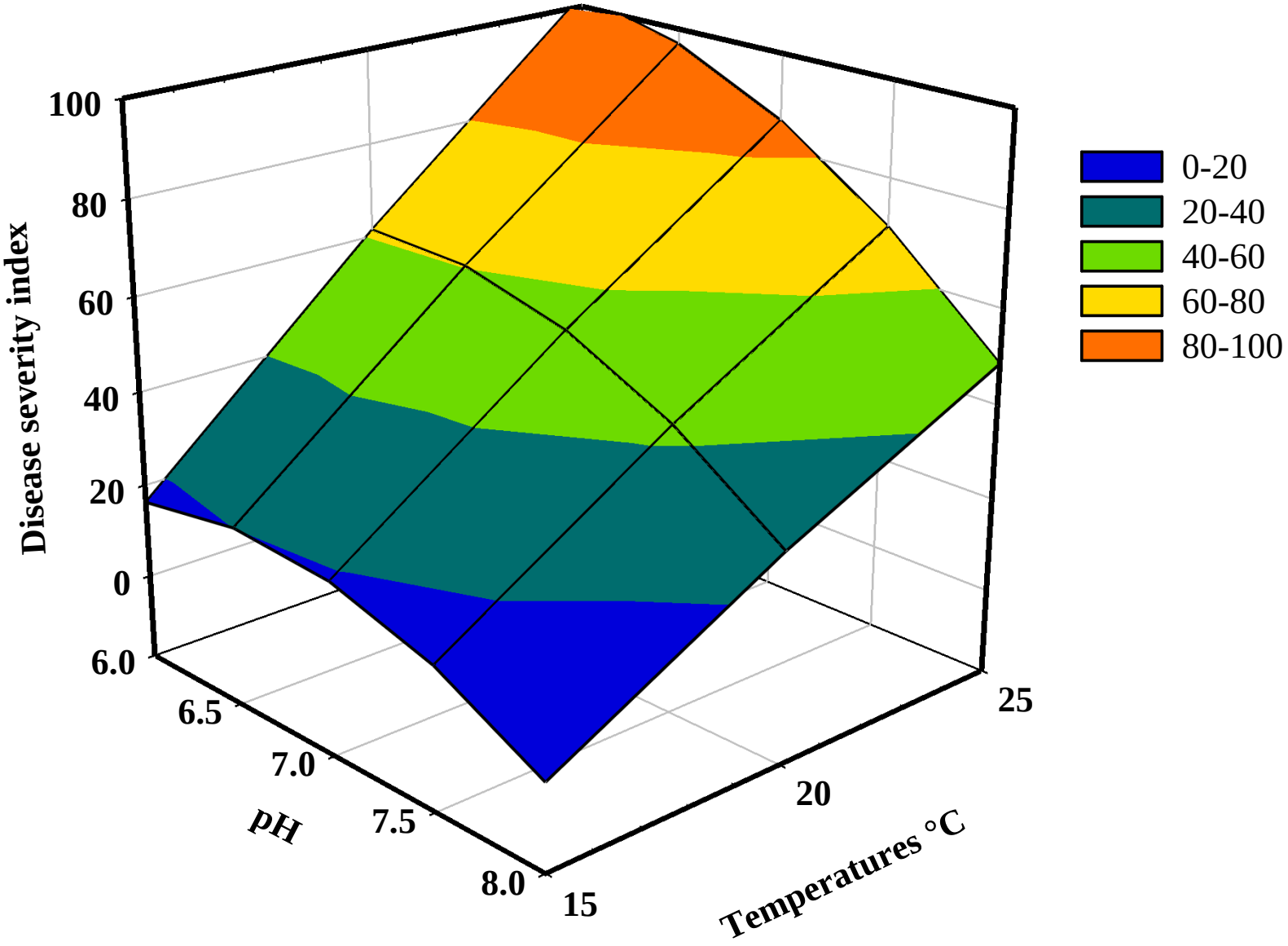
- ❑ *Strelkov et al.* – annual survey provides info on the impact of weather on clubroot severity.

- ❑ *Gossen /McDonald et al.* – impact of temperature x pH and soil type on clubroot.

Temperature x pH



Temperature x pH



Do dry conditions reduce clubroot?

- Drier conditions resulted in a small reduction in clubroot severity in ON.
- Clubroot was severe after drought delayed crop emergence, 2009.
- Conclusion – Low mean rainfall may make it more difficult for clubroot to establish, but once in place, severity could/would be high in wet years.

Does soil type affect clubroot?

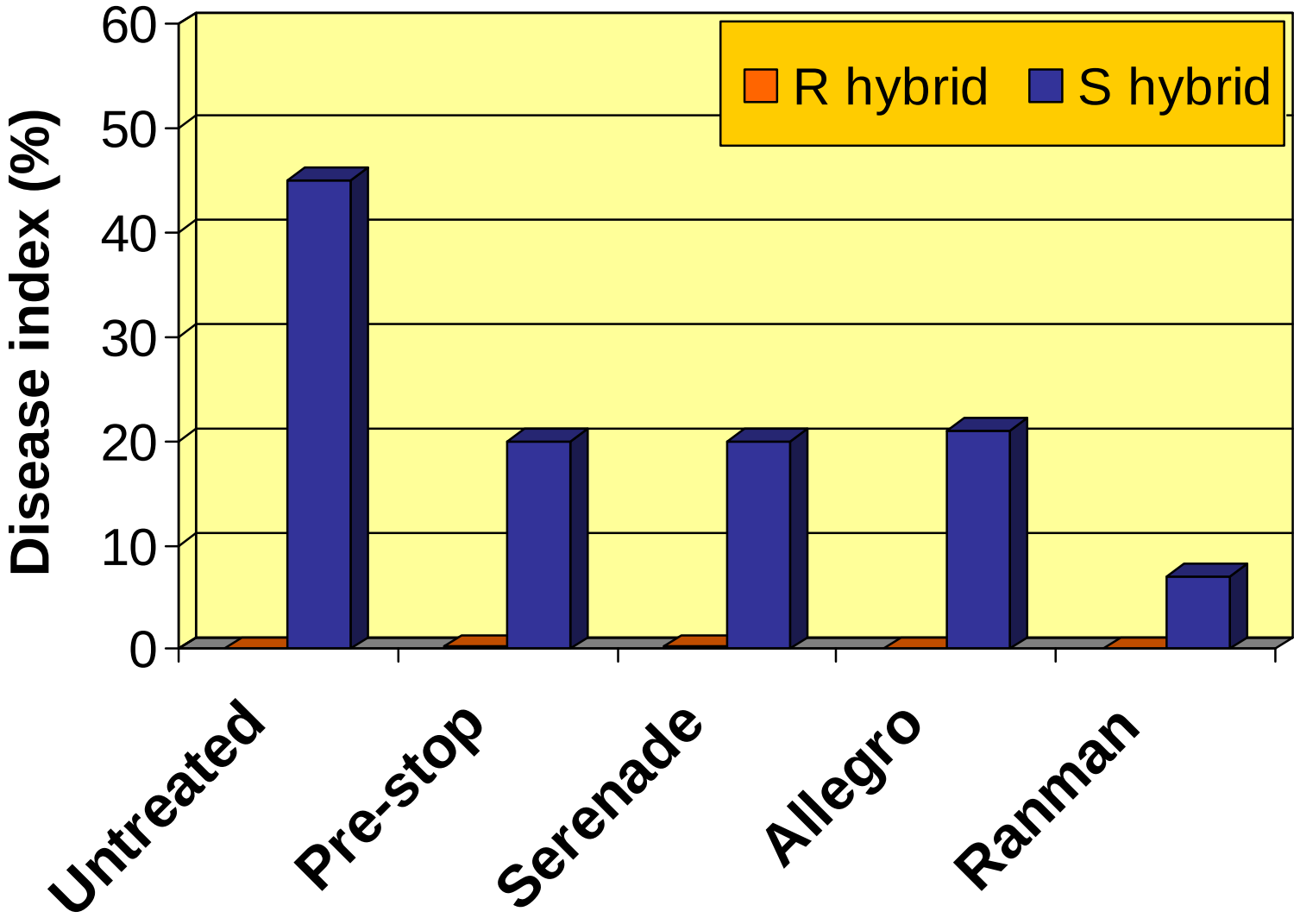
To identify interactions among soil type, pathotype (P3 and P6), and biofungicide.

Background

- Clubroot reported to be severe in heavy soils.
- Several commercial biocontrol agents showed promise against clubroot, but results not consistent, especially in field trials.
- P3 dominant in Alberta, P6 in Ontario.

Field trial, Chinese cabbage, Ontario, 2009

(Rained shortly after seeding, P6)



Materials (3 trials, canola & pak choy)

❑ Biofungicides

Prestop (*Gliocladium catenulatum*), root colonizer, mode of action is hyperparasitism

Serenade (*Bacillus subtilis*), root colonizer, mode of action is antibiotic production

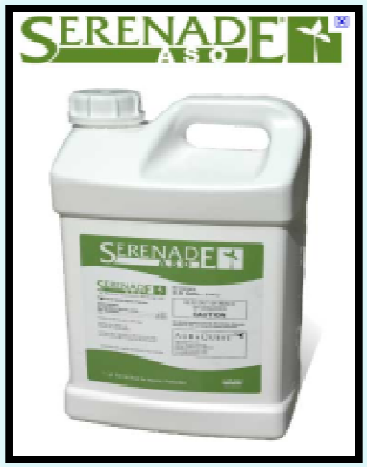
❑ Soil

Muck soil (pH~6.2, 70% o.m.)

Mineral soil (pH~6.8, 3 % o.m.)

Sand (pH~6.5, 0% o.m.)

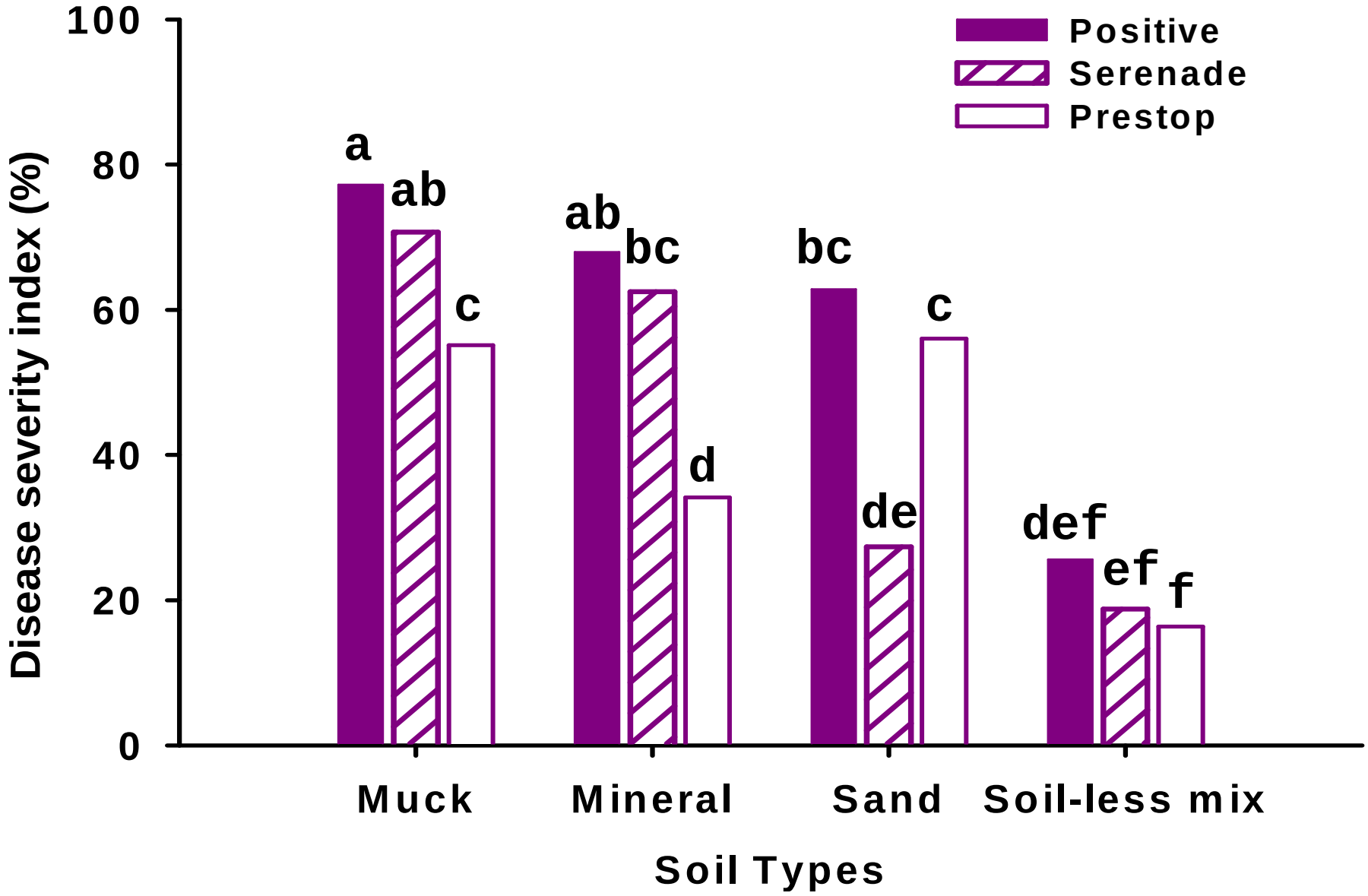
Soil-less mix (pH~6.0)



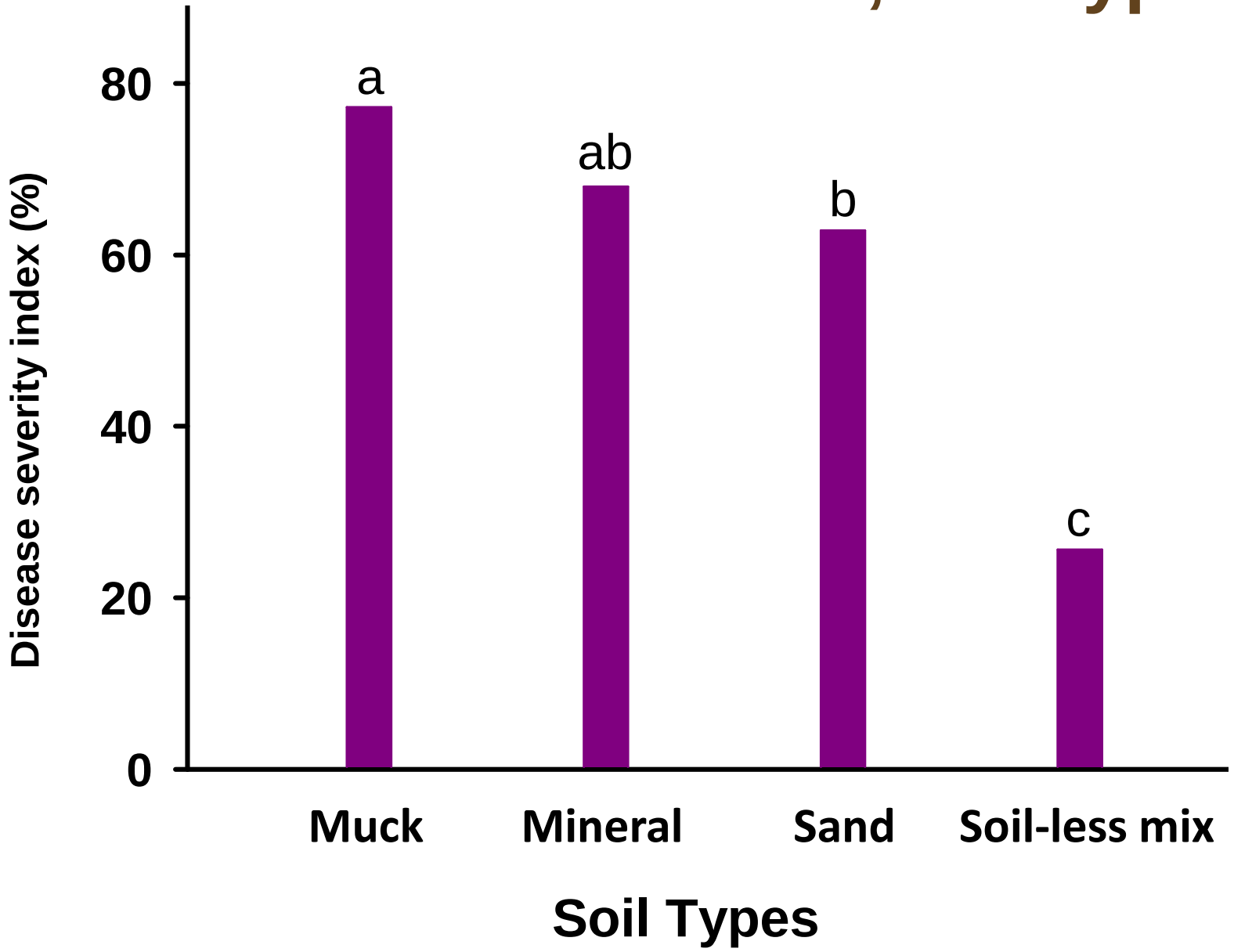
❑ Inoculum source

Pathotype 6 (Ont.), P3 (Alta.) + non-inoculated check

Soil type x biofungicide



Inoculated control, soil type



Results

- High levels of clubroot in muck and mineral soil, low in soil-less mix – generally more disease with higher bulk density.
- Clubroot more severe with P3 than P6.
- Efficacy of biofungicides was not consistent, and influenced by soil type.
- Efficacy of biofungicides even lower in companion trials with Shanghai pak choy, which is highly susceptible.

Conclusion

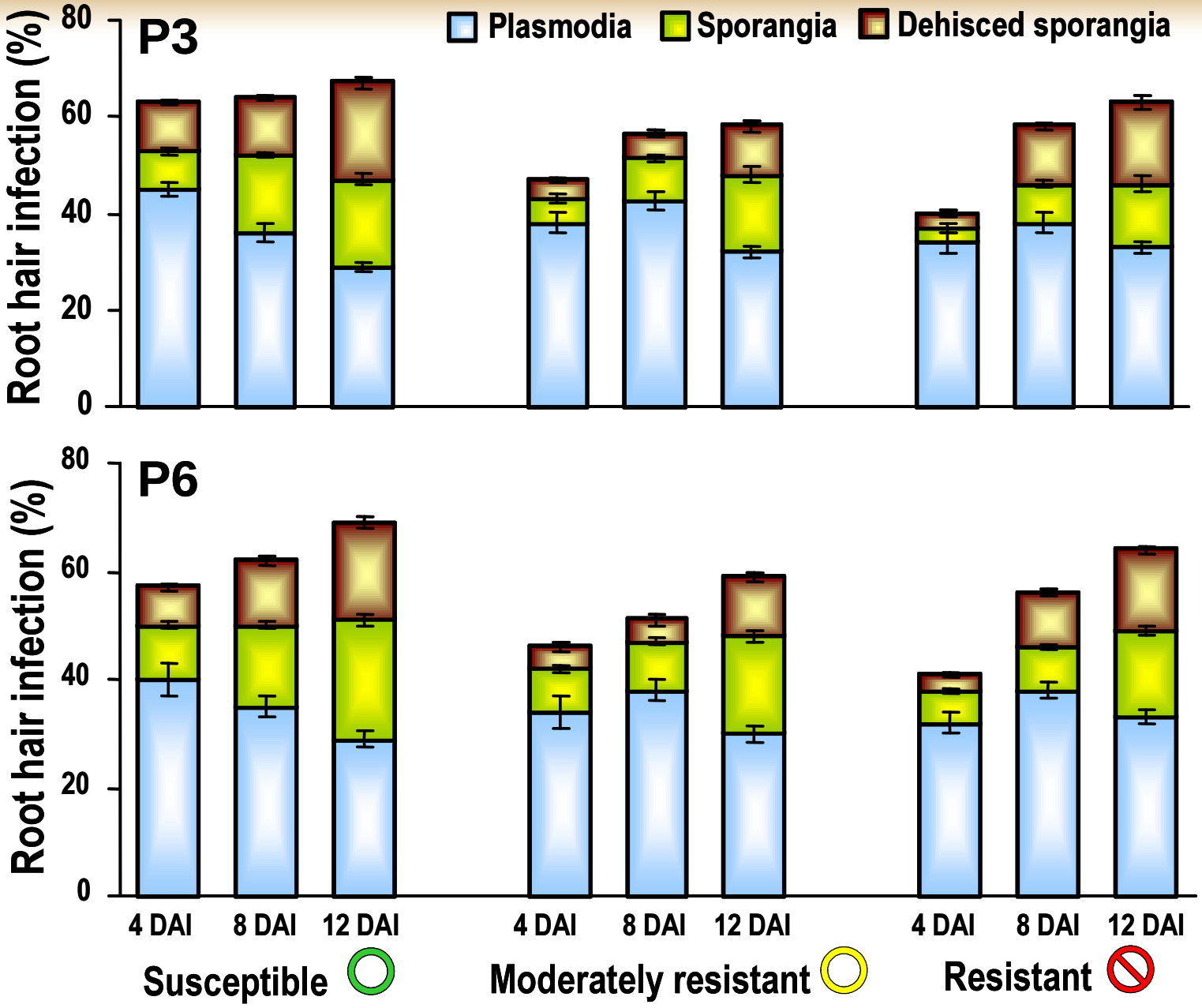
- Clubroot severity on muck soil and sand was surprisingly similar given the enormous difference in water-holding capacity. This would likely NOT occur under field conditions.
- Soil type is likely not an important factor in clubroot development when soils are saturated during crop establishment, but may have a large impact under drier conditions.
- Studies of biofungicides often use soil-less mix. Resistance assessments have also used soil-less mix. Tests of clubroot reaction in target soil types may be useful.

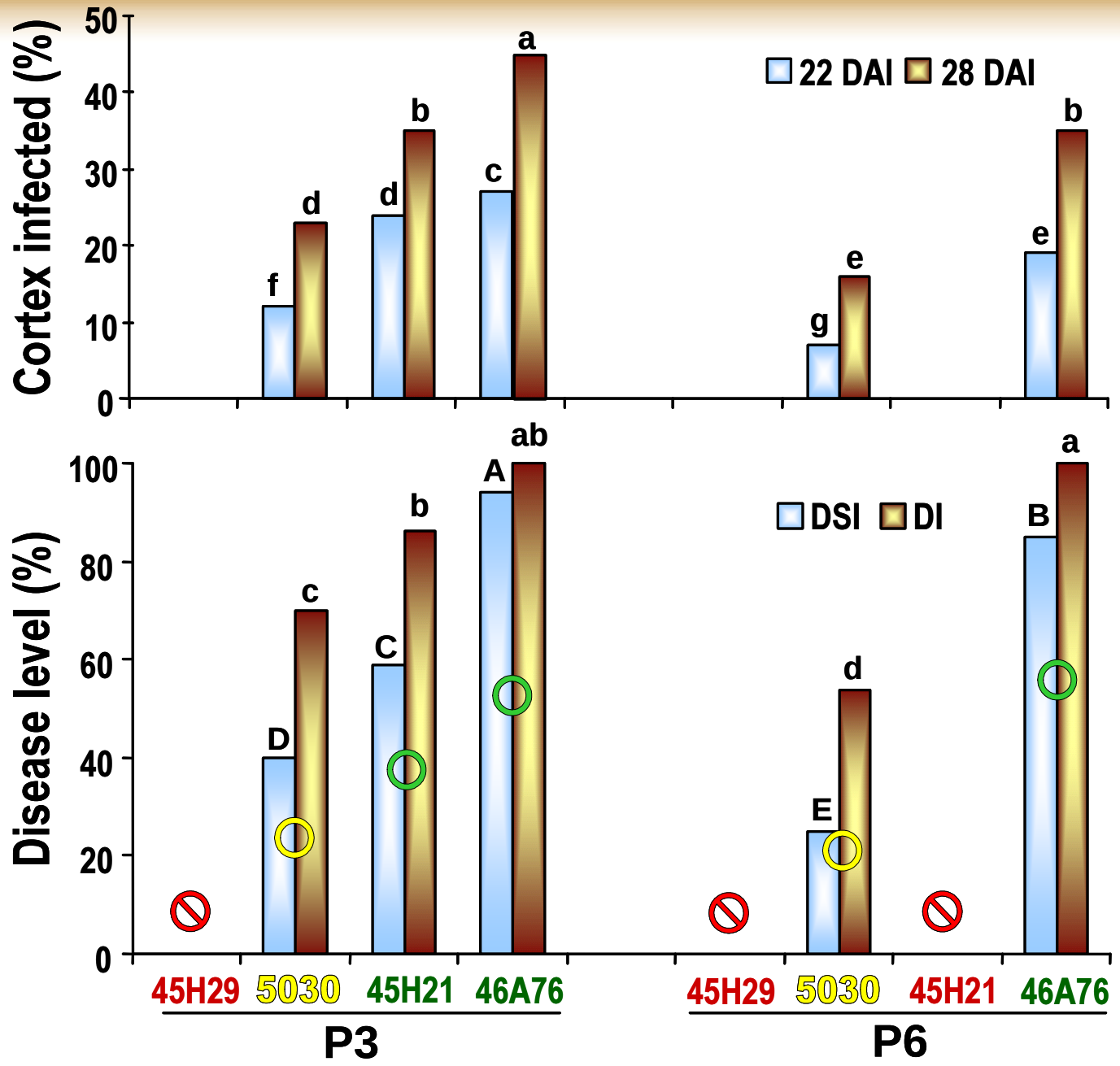
Host Resistance Study

Cultivar	P3	P6
45H29	⊘	⊘
5030	○	○
46A76	○	○
45H21	○	⊘

⊘ Resistant ○ Susceptible

○ Moderately resistant

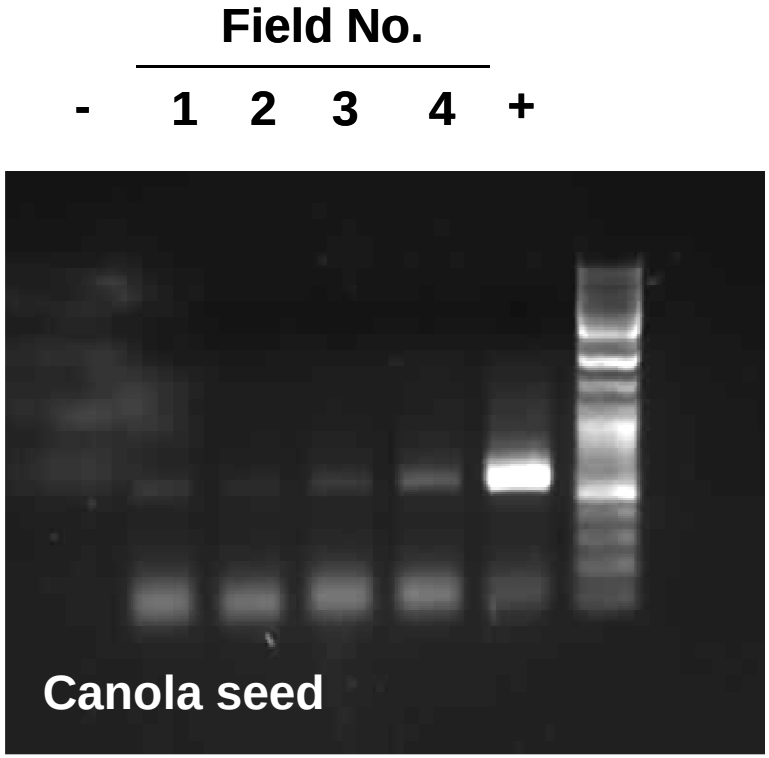

P3
Plasmodia
Sporangia
Dehisced sporangia
Root hair infection (%)
80
60
40
20
0
P6
Root hair infection (%)
80
60
40
20
0
4 DAI
8 DAI
12 DAI
4 DAI
8 DAI
12 DAI
4 DAI
8 DAI
12 DAI
Susceptible
Moderately resistant
Resistant

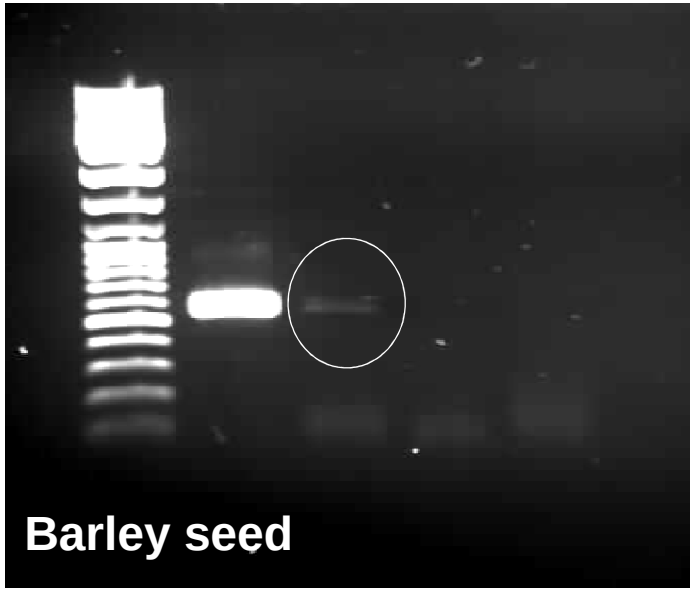

Cortex infected (%)
50
40
30
20
10
0
22 DAI
28 DAI
f
d
d
b
c
a
g
e
e
b
Disease level (%)
100
80
60
40
20
0
DSI
DI
D
c
C
b
A
ab
E
d
B
a
45H29
5030
45H21
46A76
45H29
5030
45H21
46A76
P3
P6

Conclusion

- Primary (root hair) infection - occurs in both resistant and susceptible lines, but the largest differences were between the moderately resistant line and all others.
- Cortical infection - resistance appears to inhibit secondary infection. Little or no cortical infection developed in the highly resistant lines.
- Additional studies to assess other resistant lines of canola are nearing completion, and studies of other *Brassicae* spp. are underway.

Seed Transmission?





- **PCR tests - pathogen DNA is present on seed.**
- **No evidence of seed-to-seedling transmission in trials in 2009 or 2010 (site in Ontario).**
- **One clubroot-infected plant in 2011.**

Sustainable Management/Stewardship