Control of clubroot on canola with soil microorganisms

(A new initiative)

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Challenges for clubroot control in canola

- Most commercial canola cultivars are highly susceptible (Pioneer is launching first resistant hybrid in Canada), but resistant genes for all pathogen races likely are rare and resistance maintenance will be important
- Fungicides: nothing registered for canola
- Impact of agronomic/cultural practices is not well understood for prairie conditions (rotation crops and duration, seeding dates, tillage etc.)

Additional strategies?

- Microbial antagonism?

- *Narisawa et al*. 2005. Biological control of clubroot in Chinese cabbage by *Heteroconium chaetospira*.

- *Usuki and Narisawa*. 2007.A mutualistic symbiosis between endophytic *Heteroconium chaetospira*, and Chinese cabbage.

- If microbes can colonize canola roots, they may provide durable root protection through competition, antibiosis, or induced resistance

Biocontrol of clubroot on Chinese cabbage

(K. Narisawa, Ibaraki University, Japan)

Non-treated control

H. chaetospira treatment

Several microbial biofungicides registered recently in Canada

1. Mycostop - Verdera Oy
2. Prestop - Verdera Oy
3. Root Shield - BioWorks Inc.
4. Actinovate - Natural Industries Inc.
5. Serenade - AgraQuest Inc.

Control several soil-borne diseases in horticultural crops

Synthetic fungicide Allegro (registered in Canada) and Ranman (registered in NZ & Taiwan) - control of clubroot on vegetable crucifers

Objectives:

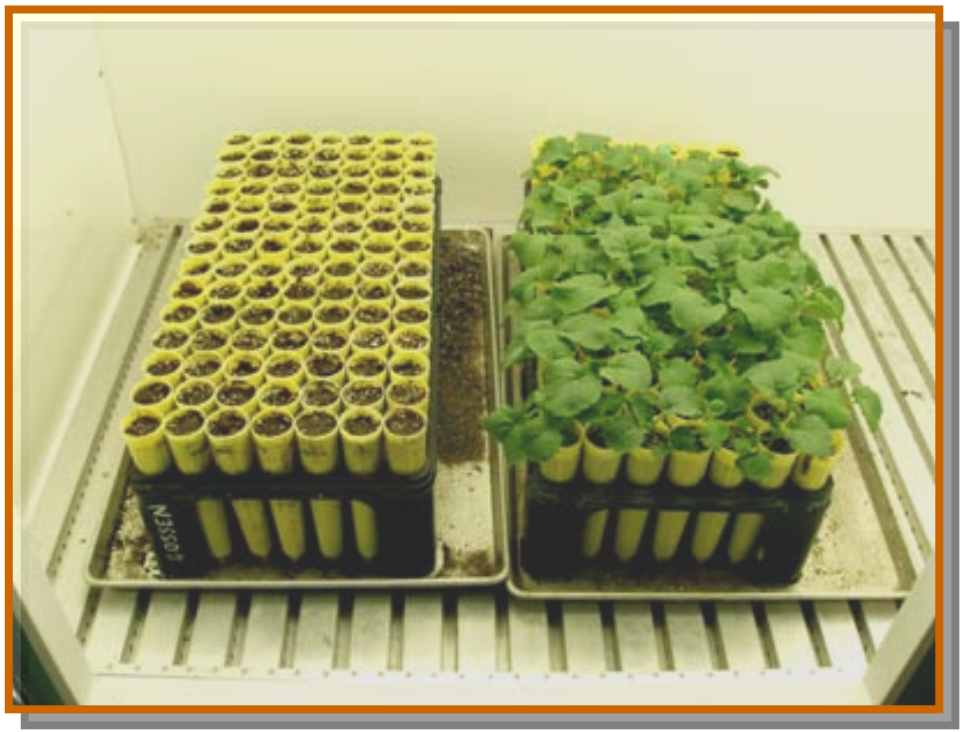
- Evaluate selected microbial biofungicides and synthetic fungicides for control of clubroot on canola
- Isolate and evaluate indigenous soil microbes (rhizosphere or endophytic inhabitants from canola roots) for most desirable agents against clubroot

Procedures

1. **A clubroot bioassay for efficacy screening**
2. **Efficacy trials in controlled conditions**
   - ❑ Growth cabinet in containment at AAFC Saskatoon
   - ❑ Greenhouse at CDC north, Edmonton
   - ❑ Greenhouse trials at U of Guelph – (vegetable)
   - ❑ Soil drench application and seed treatment
3. **Survey and evaluate indigenous soil microbes**
   - ❑ Isolating rhizosphere/endophytic inhabitants from canola roots
   - ❑ Tiered bioassay system for efficacy evaluation

- *Plasmodiophora brassicae* (Pb) inoculum: prepared with galls from multiple fields in central Alberta
- Pb concentration: **10^6** to **10^8** resting spores/ml, applied around canola plants at 2-5 ml/plant
- Clubroot rating 3 wks after inoculation

Clubroot bioassay



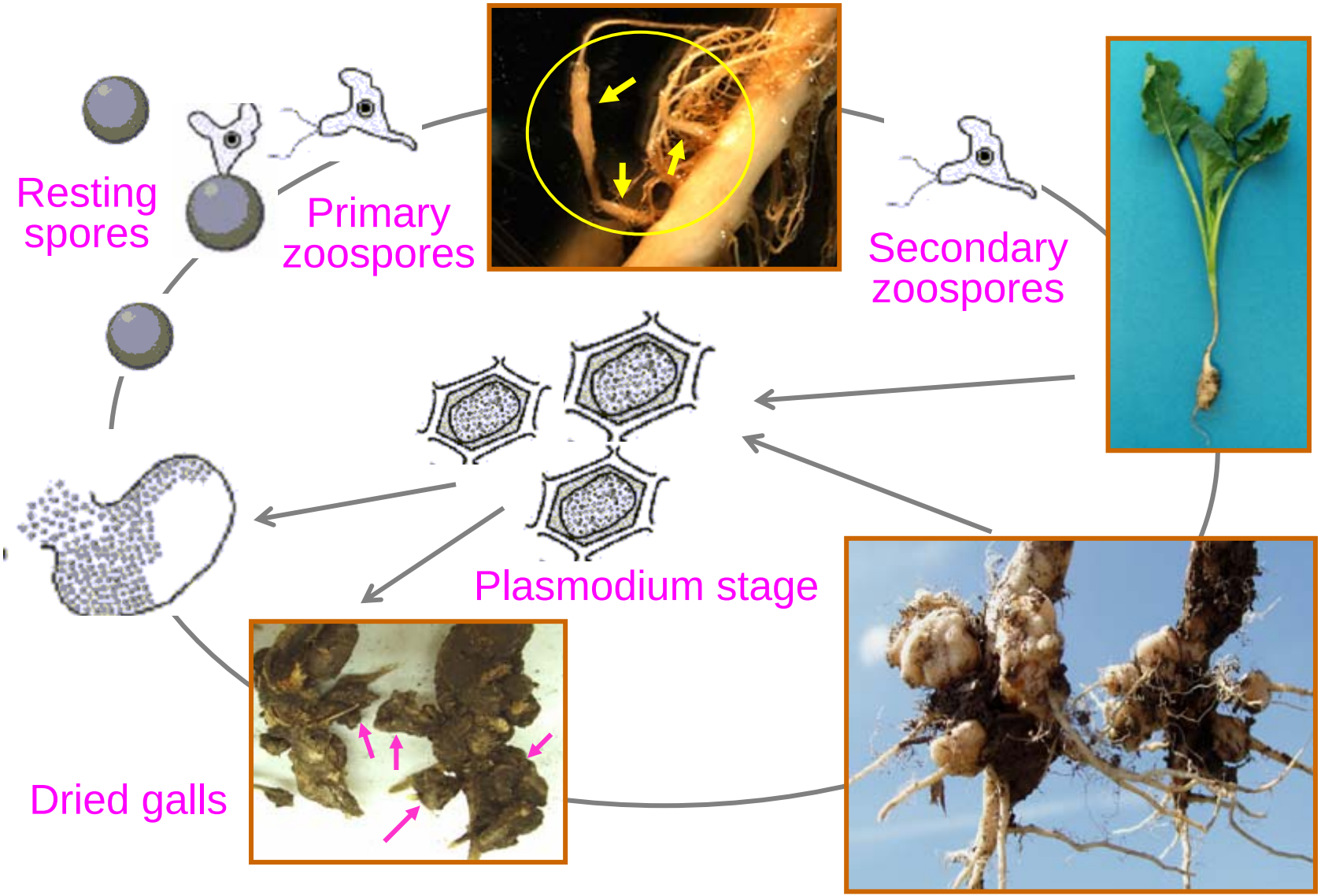
Clubroot rating scale

A 0-3 scale was used: 0= no galling; 1= small galls only, on less than 1/3 of roots; 2= small or medium-sized galls on 1/3 to 2/3 of roots; and 3= severe galling, medium to large-sized galls on more than 2/3 roots

Disease index (DI) was calculated for each treatment/rep based on the weight of each rating class observed

DI = $\sum$ (severity class x No. of plants in the class) x100 / (total No. of plants in the rep) x3

Life cycle: two-phased infection process

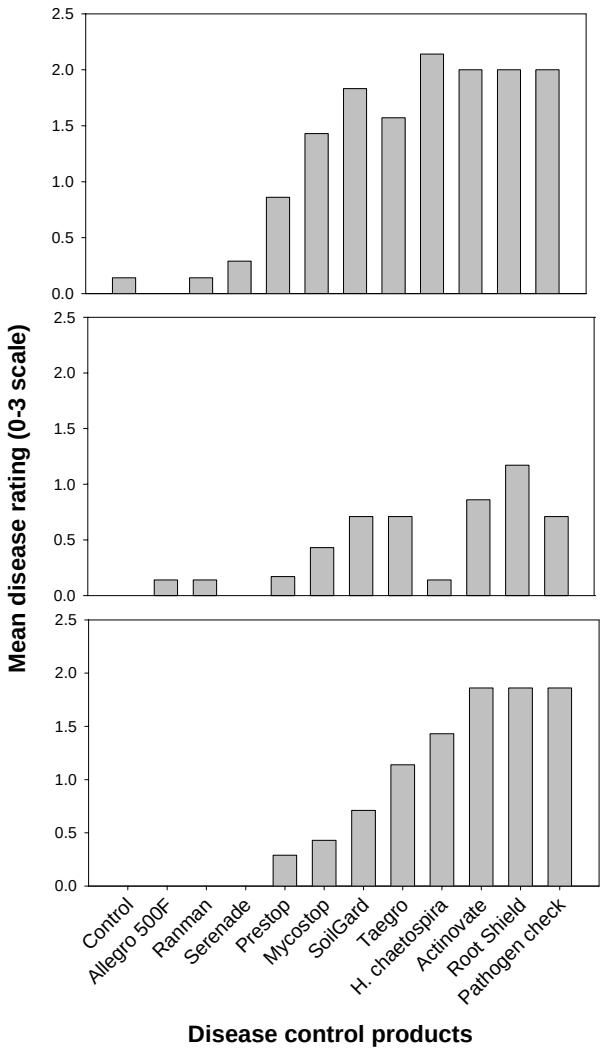


Efficacy trial protocol

- **Product rates:**
  1. Microbial fungicides: 5x label-rate concentrations
  2. Fungicides:1x label rates
- **Timing of treatment and Pb inoculation:**
  1. Treatments applied 3d prior to Pb (7d after seeding)
  2. Treatments applied just prior to Pb (7d after seeding)
  3. Pb 1 d prior to seeding, treatments applied at seeding (simulates in-furrow application)
  4. Treated seeds were planted into naturally infested field soils

I. Efficacy in growth cabinet trials

Treatments applied 3d prior to Pb - **AAFC Saskatoon**



Average efficacy over 3 trials

Treatments applied 3d prior to Pb – **AAFC Saskatoon**

Treatment	Mean disease index	Disease reduction (%)
Untreated control	0.0 a	NA
Allegro 500F	3.2 a	91.2
Ranman	3.2 a	91.2
Serenade	3.2 a	91.2
Prestop	6.9 a	81.1
Mycostop	14.3 b	60.8
Pathogen control	36.5 d	0.0
Actinovate	39.7 d	- 8.7
Root Shield	46.6 de	- 27.6

Efficacy in greenhouse (CDC North, Edmonton)

Treatments applied just prior to Pb (7d after seeding)

Treatment	Disease index (%)	
	Trial 1	Trial 2
Pathogen CK	100 a	75.8 a
Mycostop	93.3 ab	33.3 b
Root Shield	90.8 abc	22.5 c
Serenade	87.5 bc	2.5 e
Prestop	87.5 bc	13.1 cd
Actinovate	85.8 bc	8.4 de
Calcium cyanamide	82.5 c	1.7 e
Allegro 500	0 d	0 e
Ranman	0 d	0 e

Efficacy: Pb applied to soil prior to treatment

(simulate in-furrow drench at seeding) – **AAFC Saskatoon**

Treatment	Disease index (%)		Avg. efficacy (%)
	Trial 1	Trial 2	
Pathogen CK (10^7)	33.3	50.0	0
Pathogen CK (10^8)	50.0	72.2	0
Prestop (Pb 10^7)	4.8	4.8	92.8
Prestop (Pb 10^8)	22.2	9.5	71.2
Serenade (Pb 10^7)	14.3	0.0	78.6
Serenade (Pb 10^8)	9.5	0.0	90.5
Allegro (Pb 10^7)	9.5	0.0	85.8
Allegro (Pb 10^8)	0.0	4.8	96.7
Ranman (Pb 10^7)	9.5	0.0	85.8
Ranman (Pb 10^8)	14.3	9.5	79.1

Efficacy of seed treatment in greenhouse trials

(CDC north, Edmonton)

Treatment [1]	Disease index (%)	
	Trial 1	Trial 2
Pathogen CK	100 a	80.0 a
Mycostop	95.8 ab	55.6 bcd
Root Shield	99.2 a	68.4 ab
Serenade	94.2 abc	49.5 cd
Prestop	91.7 abc	61.1 bc
Actinovate	90.8 abc	58.7 bc
Calcium cyanamide	85.8 c	31.2 e
Allegro 500	89.2 bc	40.1 de
Ranman	75.0 d	33.7 e

[1] Treated seeds were planted into infested field soils

II. Screening indigenous microorganisms

Tier I: antibiosis or competition assay

2,500 isolates assessed

Tier II: Pythium damping-off assay

308 endophytic isolates assessed

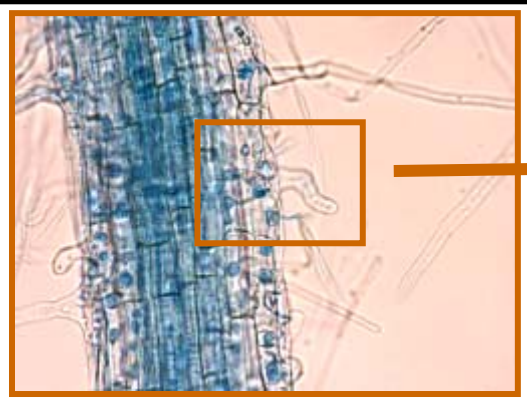
Tier III: Clubroot bioassay

176 isolates assessed, more effective candidates are being discovered

III. Microbial formulation – *Heteroconium chaetospira*

Treatment (10% *H.c.* formulation)	Disease index (%)		Avg. efficacy (%)
	Trial 1	Trial 2	
Pathogen CK (10^7)	41.7 a	50.0 b	0
Pathogen CK (10^8)	NA	72.2 a	0
H. chaetospira (Pb 10^7)	11.1 b	0 c	86.7
H. chaetospira (Pb 10^8)	NA	0 c	100

H. Chaetospira **can colonize canola roots**



H. Chaetospira **microsclerotia germinating in root cells**

Summary

- Several fungicides & biofungicides showed attractive efficacy
- Disease pressure, application timing important to microbial performance
- More efficacious microbes are being discovered in indigenous populations – further development is required
- Formulation technologies need to be developed for practical field delivery – seed treatment or in-furrow applications with seeding

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