Fungicides/biofungicides, Cultivar resistance, crop rotation for control of clubroot on canola

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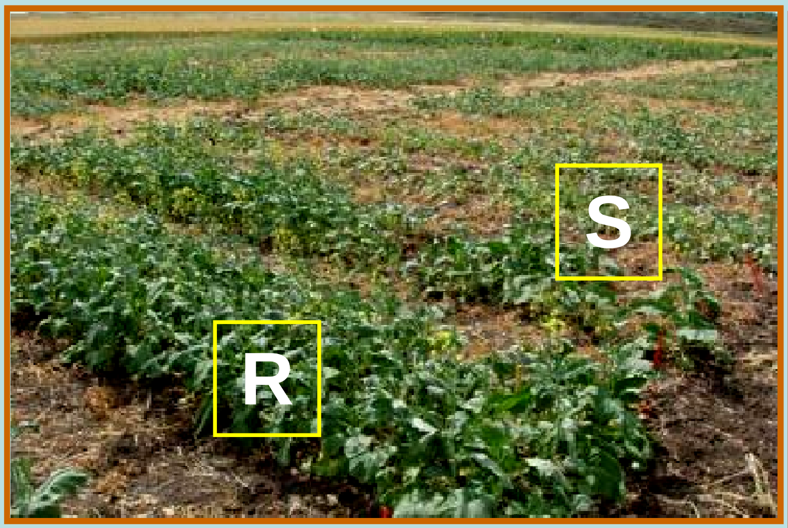
Resistance is the cornerstone in clubroot management

- Effective
- Economical
- Easy to use

Research plots



Commercial fields

Resistant cultivars

- resistant, but not immune
- none of the R genes is effective for all races
- resistance can be eroded with a change of pathogen race structure

Questions:

- How long will the resistance last?
- Is resistance alone enough?
- anything else that may help?
- Resistance stewardship

Additional control strategies

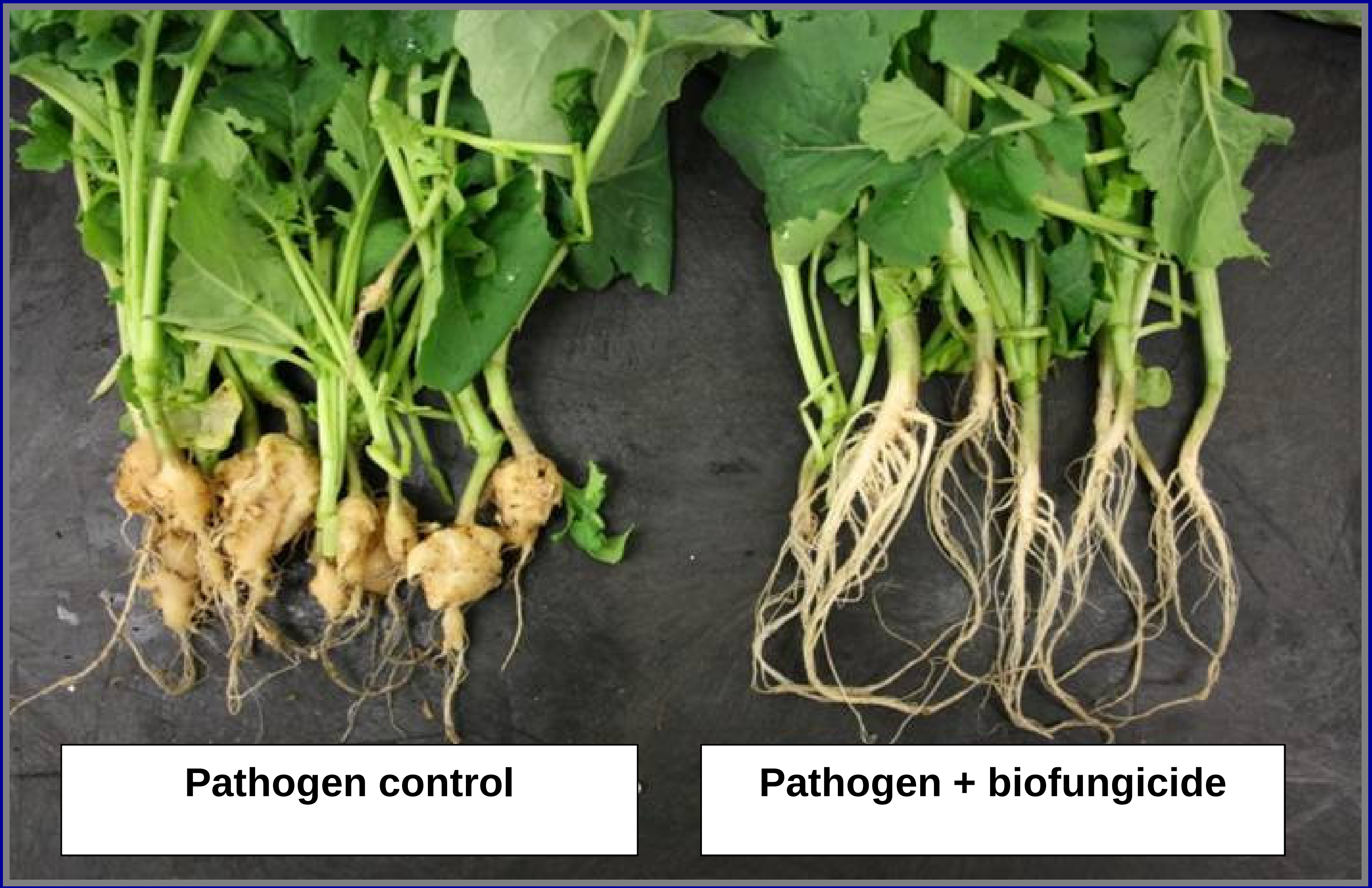
- Fungicides or biofungicides?
  - Cheah LH et al. 1998. Soil-incorporation of fungicides for control of clubroot of vegetable brassicas. *Proc of 51st NZ Plant Prot. Conf*. pp. 130–133.
  - Cheah LH et al. 2000. Biological control of clubroot on cauliflower with *Trichoderma* and *Streptomyces* spp. *NZ Plant Prot* **53**, 18–21.
  - Narisawa K et al. 1998. Suppression of clubroot formation in Chinese cabbage by the root endophytic fungus, *Heteroconium chaetospira*. *Plant Pathol*. **47**, 206–210
  - Peng G et al. 2011. Potential biological control of clubroot on canola and crucifer vegetable crops. *Plant Pathol* 60:566-574
- Crop rotation?
  - Wallenhammar AC, 1996. Prevalence of *Plasmodiophora brassicae* in a spring oilseed rape growing area in central Sweden and factors influencing soil infestation levels. *Plant Pathol*. **45**, 710–719.

Biofungicides & fungicides

- **Serenade** (*Bacillus subtilis)*
- **Prestop** (*Clonostachys rosea*)
- **Allegro** (Fluazinam)
- **Ranman** (Cyazofamid)

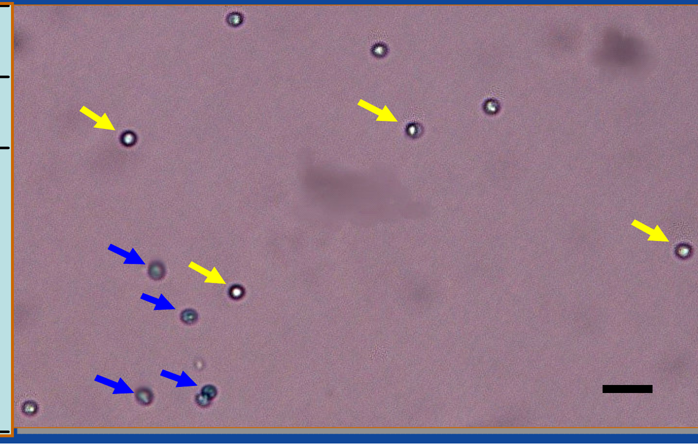
All applied as a liquid formulation

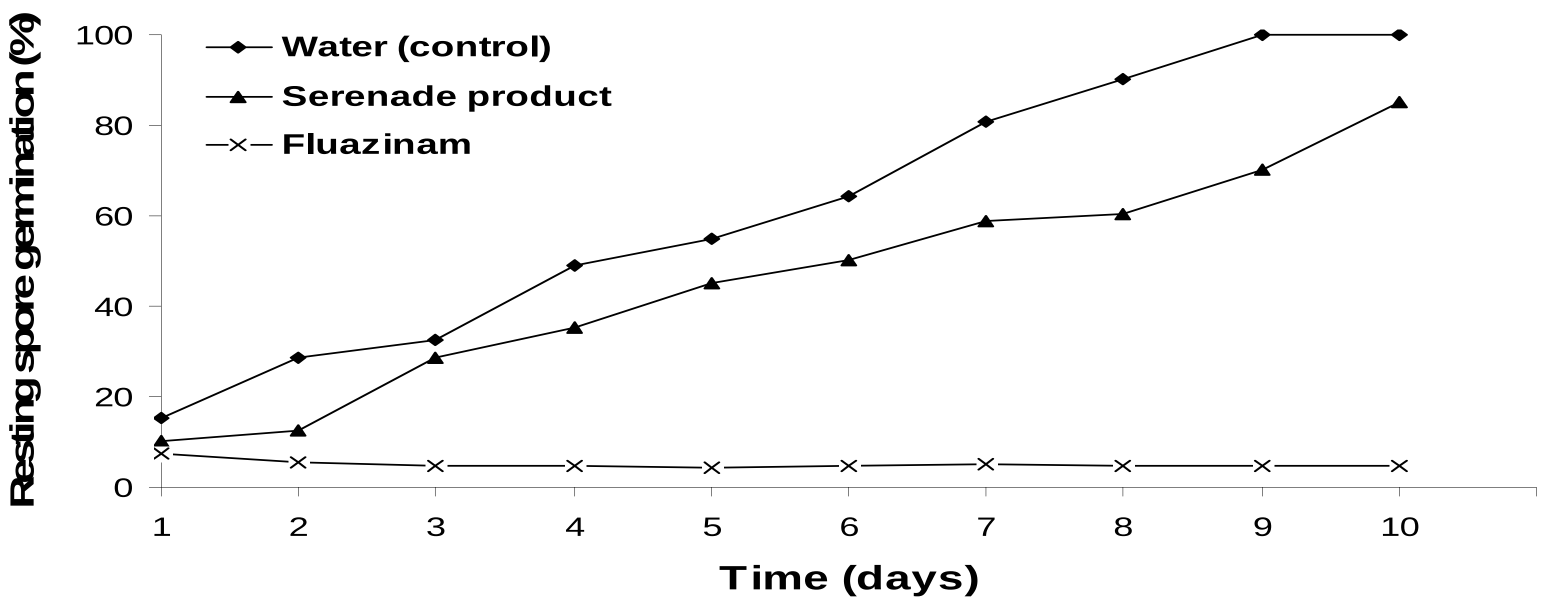
Selected products: soil drench was highly effective in controlled conditions



Modes of action for Biofungicides

Treatment	Avg. disease index (%)	
	Prestop	Serenade
Formulated product	2 a	7 a
Product filtrate (cell free)	11 a	33 a
Spore/cell suspension	50 b	36 a
Pathogen control	93 c	100 b

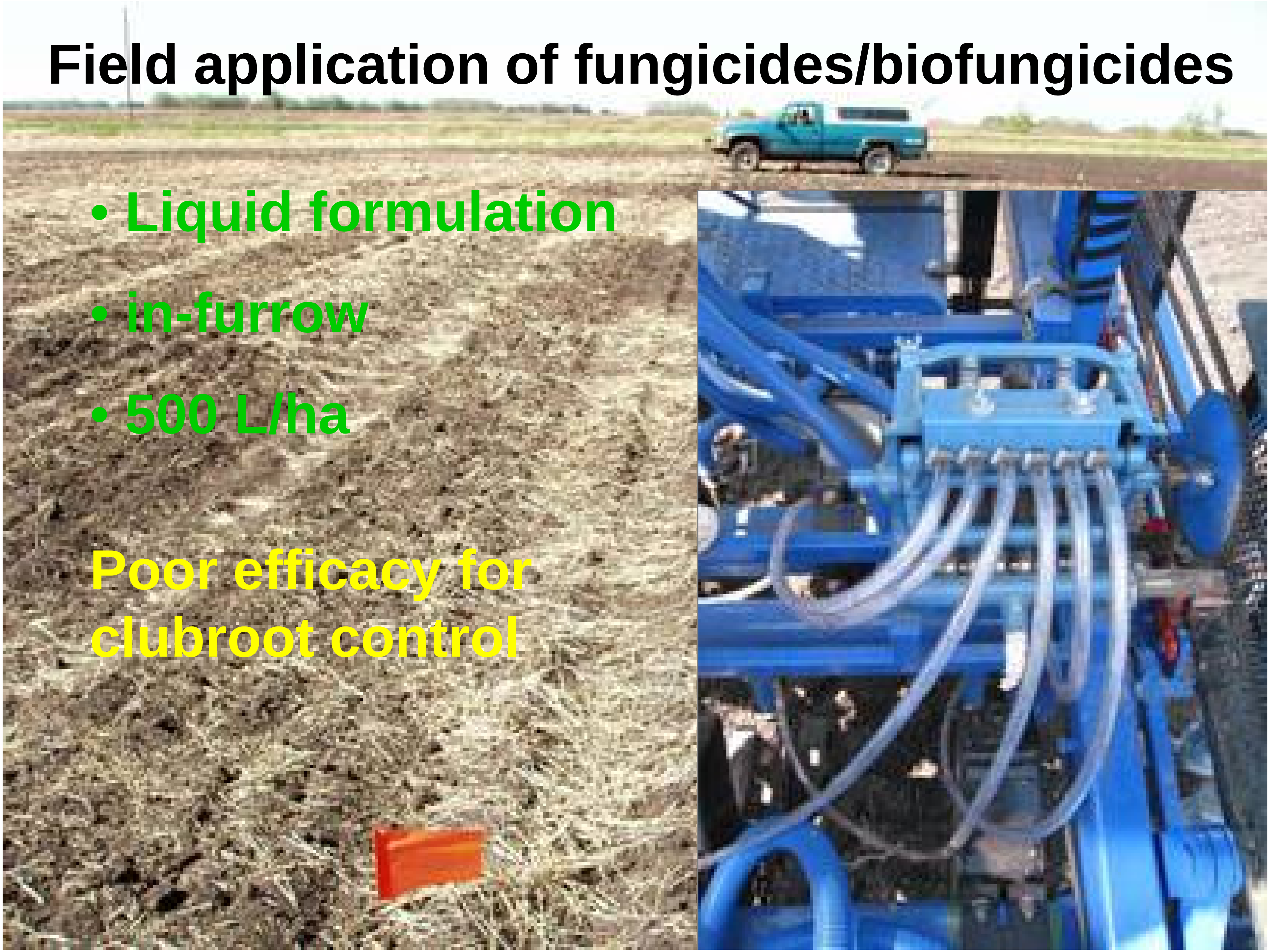




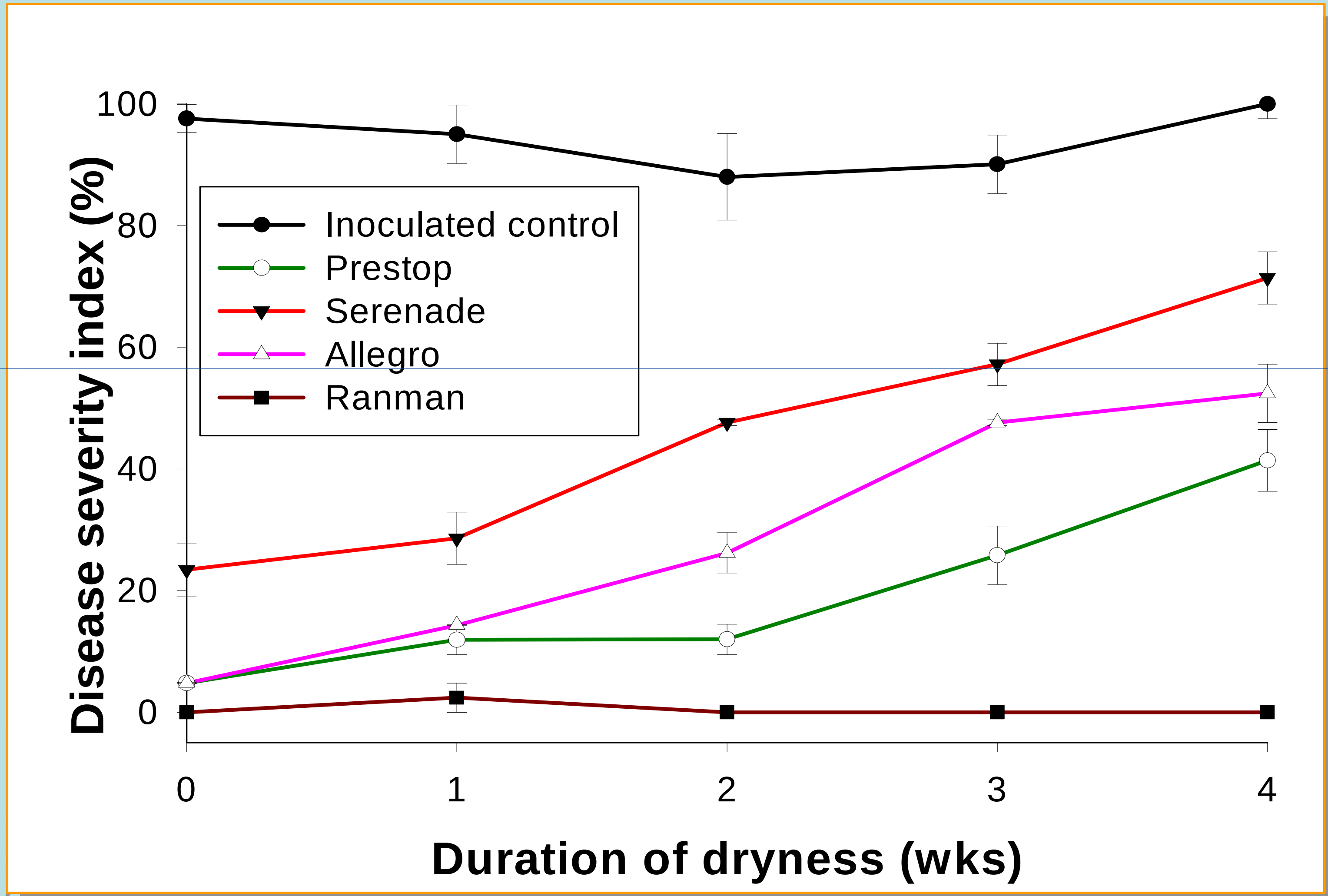
Field application of fungicides/biofungicides

- Liquid formulation
- in-furrow
- 500 L/ha

Poor efficacy for clubroot control

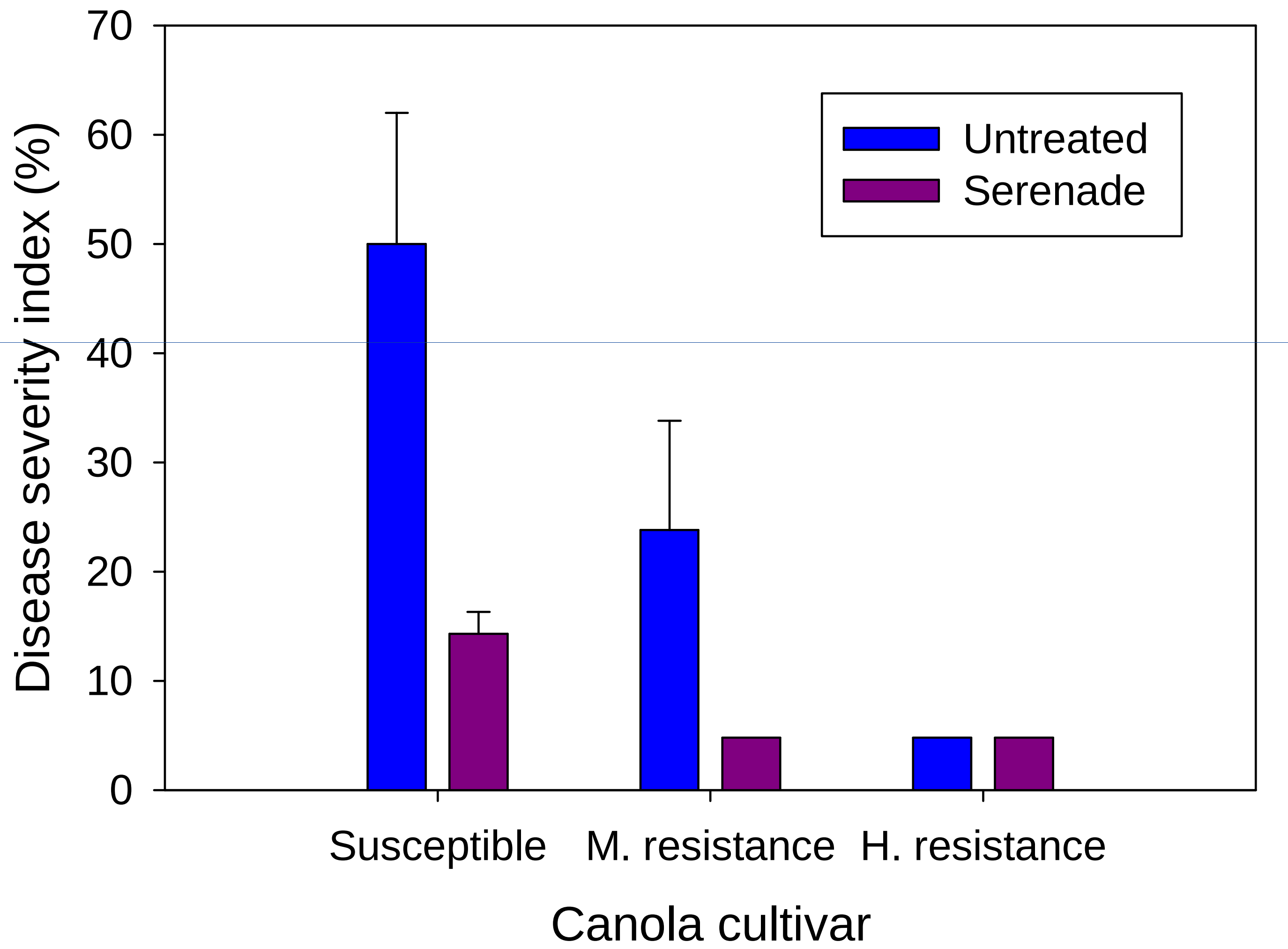


Effect of soil dryness on efficacy
(under controlled conditions)



Using the biofungicide Serenade with CR canola cv. (n=2)

In controlled conditions



Granular formulation of *Bacillus subtilis*

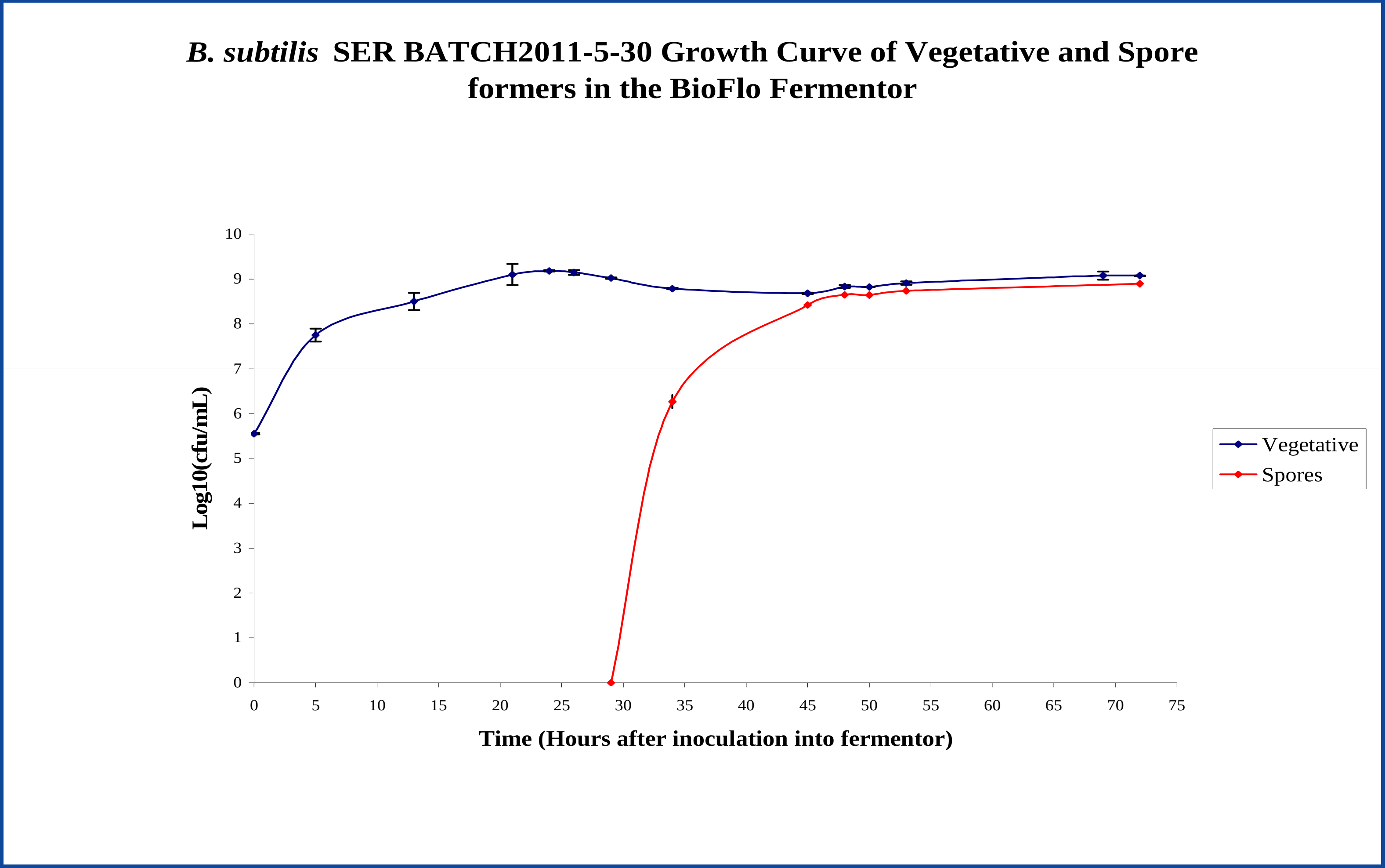
GOAL: deliver a high population of the biopesticide to the canola rhizosphere

- maximize *Bacillus subtilis* “spore” production in the fermenter
- develop cost effective formulations

Formulation types

- Granules
- Seed coating

Fermentation of *B. subtilis* – optimal "spore" production

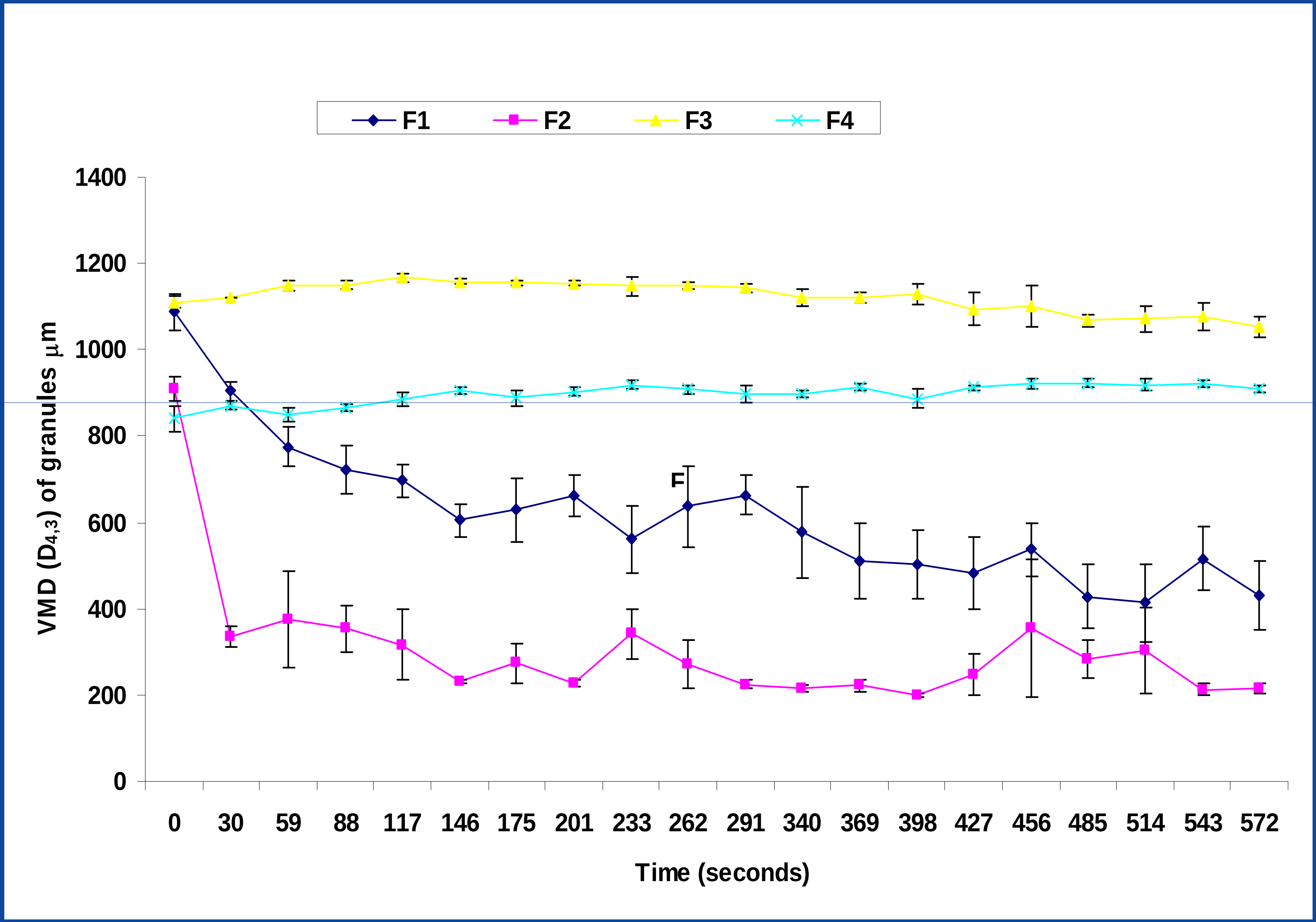


Bacillus subtilis granule formulations

Formulation	Ingredients	*B.subtilis* (mL)
A	Bentonite clay, corn starch, peat	75
A2	Bentonite clay, corn starch, peat	100
B	Bentonite clay, pea starch, peat	100
C	Bentonite clay, corn starch, peat, CMC	100
D	Bentonite clay, corn starch, peat, CMC	100
E	Bentonite clay, corn starch, peat, PVP	100
F	Exlite pea fibre, peat	250
G	Bentonite clay, corn starch, peat, PVP	100
G2	Bentonite clay, corn starch, peat, PVP	125
H	Bentonite clay, corn starch, peat, CMC	125
I	Bentonite clay, exlite pea fibre, peat	175
I2	Bentonite clay, exlite pea fibre, peat	200
J	Bentonite clay, exlite pea fibre, peat, PVP	175
K	Bentonite clay, exlite pea fibre, peat, CMC	200
Z	Corn starch, peat	171

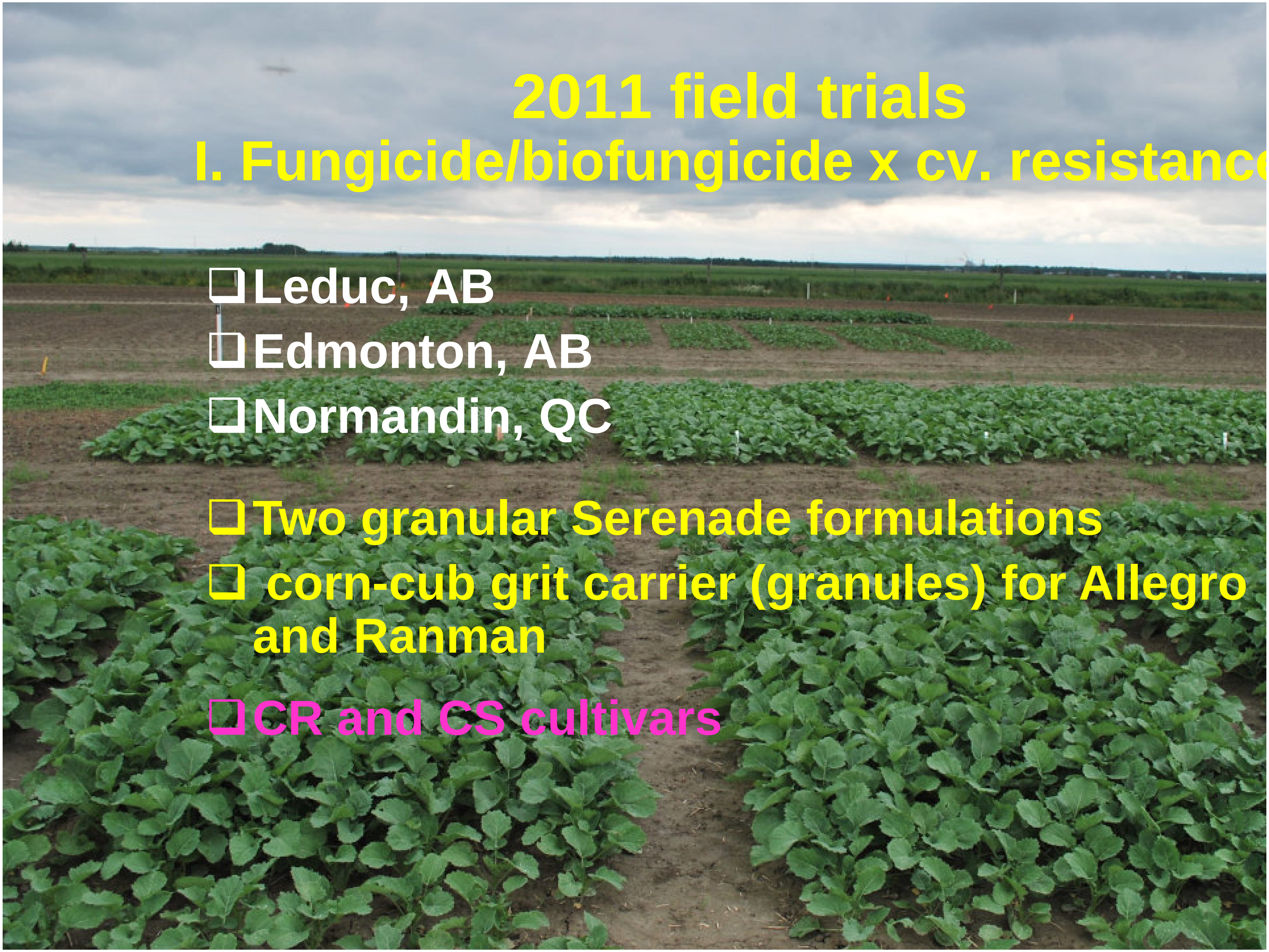

Extrusion
Extrudate
Spheronization
Granular formulations

Disintegration rate of granules



Corn-cub-grits granular formulation

- Easy to apply with canola seeding
- Granule source abundant & inexpensive
- Effective in controlled conditions
- Field application: 50 Kg/ha



2011 field trials

I. Fungicide/biofungicide x cv. resistance

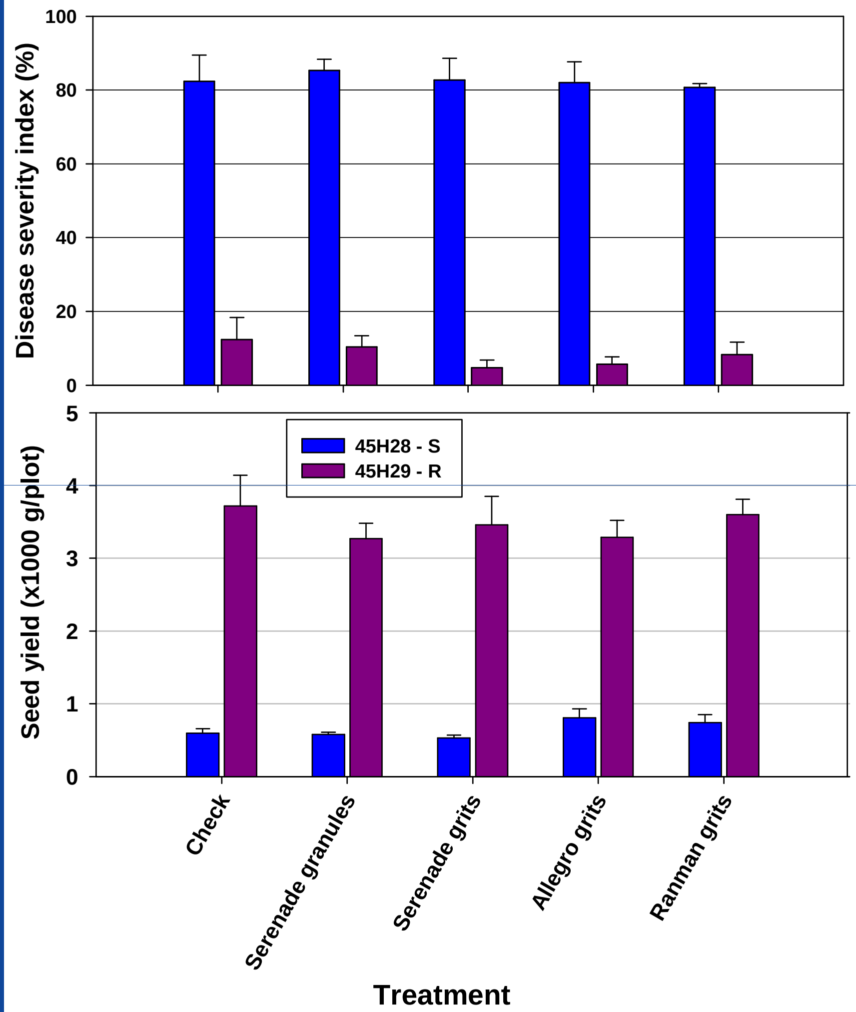
- ❑ Leduc, AB
- ❑ Edmonton, AB
- ❑ Normandin, QC

- ❑ Two granular Serenade formulations
- ❑ corn-cub grit carrier (granules) for Allegro and Ranman

- ❑ CR and CS cultivars

Leduc, AB (2011)

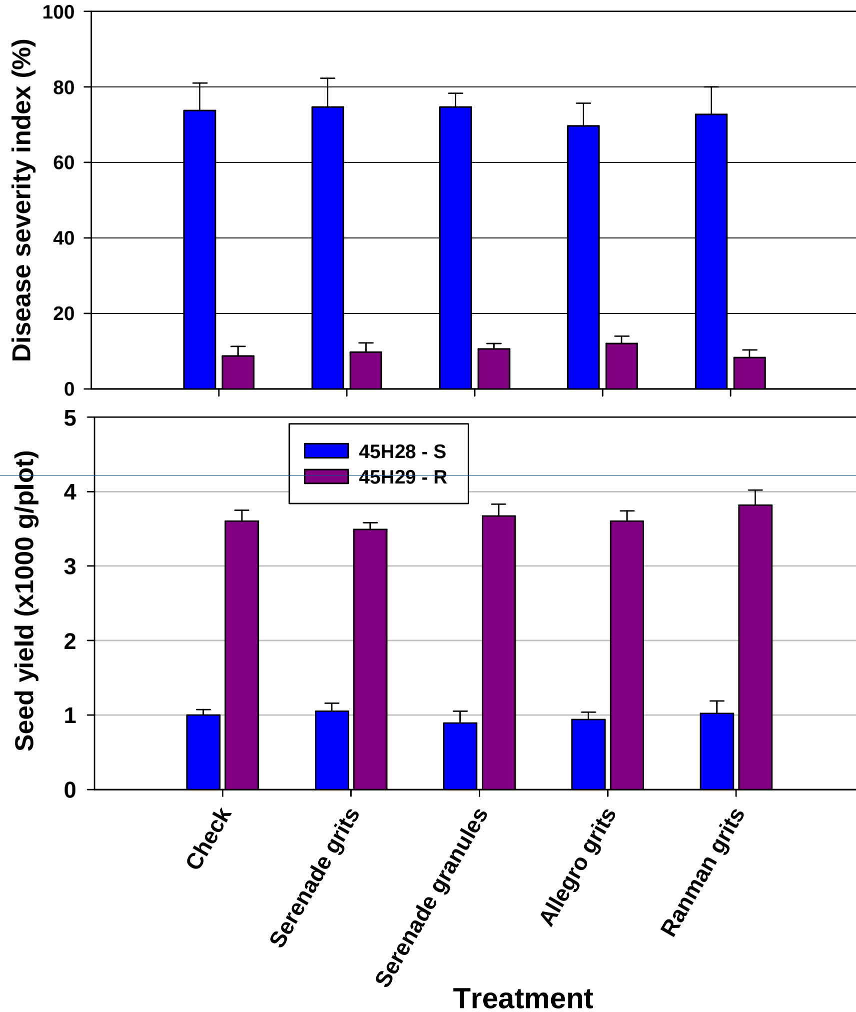
- cv. resistance was highly effective; with substantial clubroot reduction and yield increase
- None of fungicide or biofungicide treatments was effective



Seeding date: May 28, 2011

Edmonton, AB (2011)

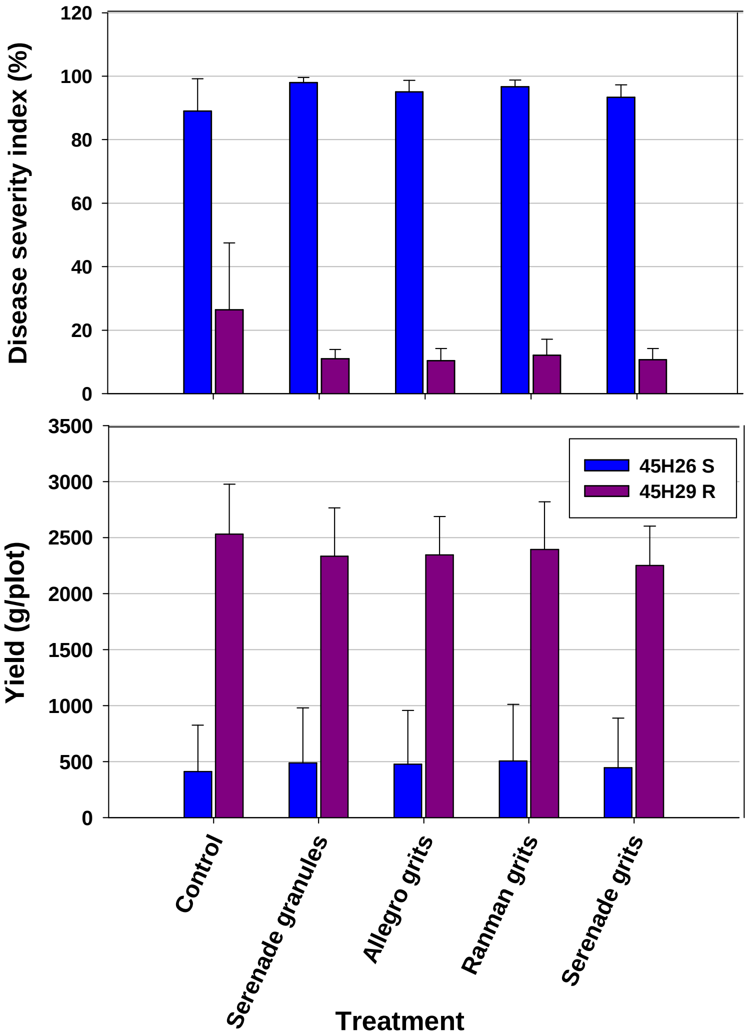
Almost exactly the same pattern as in Leduc, AB

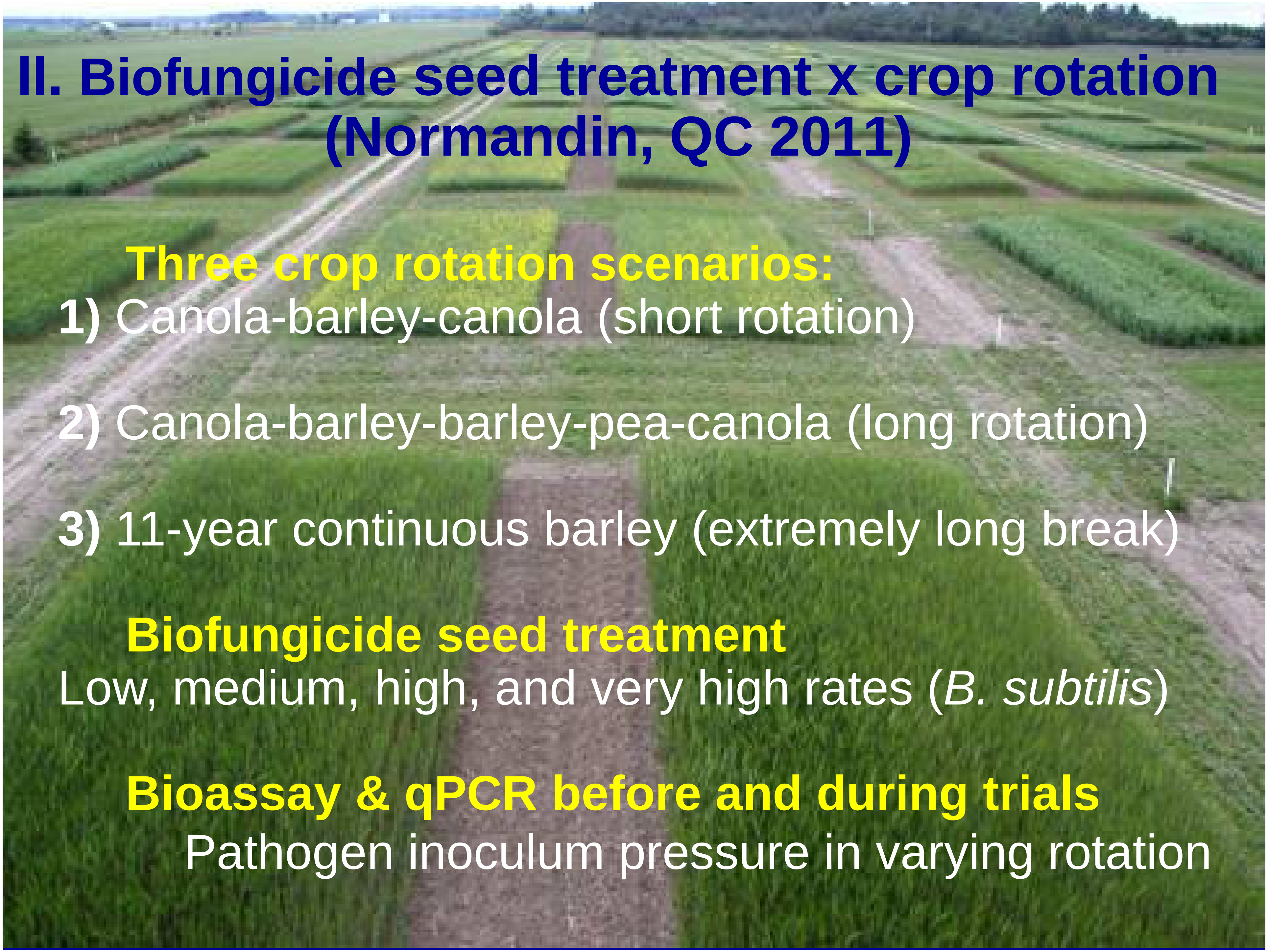


Edmonton, AB
Seeding date: June 2, 2011

2011 field trials

Normandin, QC





II. Biofungicide seed treatment x crop rotation (Normandin, QC 2011)

Three crop rotation scenarios:

1) Canola-barley-canola (short rotation)

2) Canola-barley-barley-pea-canola (long rotation)

3) 11-year continuous barley (extremely long break)

Biofungicide seed treatment

Low, medium, high, and very high rates (*B. subtilis*)

Bioassay & qPCR before and during trials

Pathogen inoculum pressure in varying rotation

Table 4. Estimate of *Plasmodiophora brassicae* inoculum pressure (soil-sample bioassay) and early pathogen development in canola roots using qPCR in plots of varying crop-rotation history (2011). [A]

Crop rotation	Bioassay	qPCR (ng/g fresh root)	
(Year of break)	(%DSI)	Field trial 1	Field trial 2
1	74.8 a	11.6 a	2364 a
3	47.0 b	7.3 b	8.4 b
11	28.3 c	8.7 b	3.2 c

[A] Soil samples were taken prior to the trials and root samples were taken from nontreated control plots 4 weeks after seeding.

Results

Clubroot severity index

1-year break

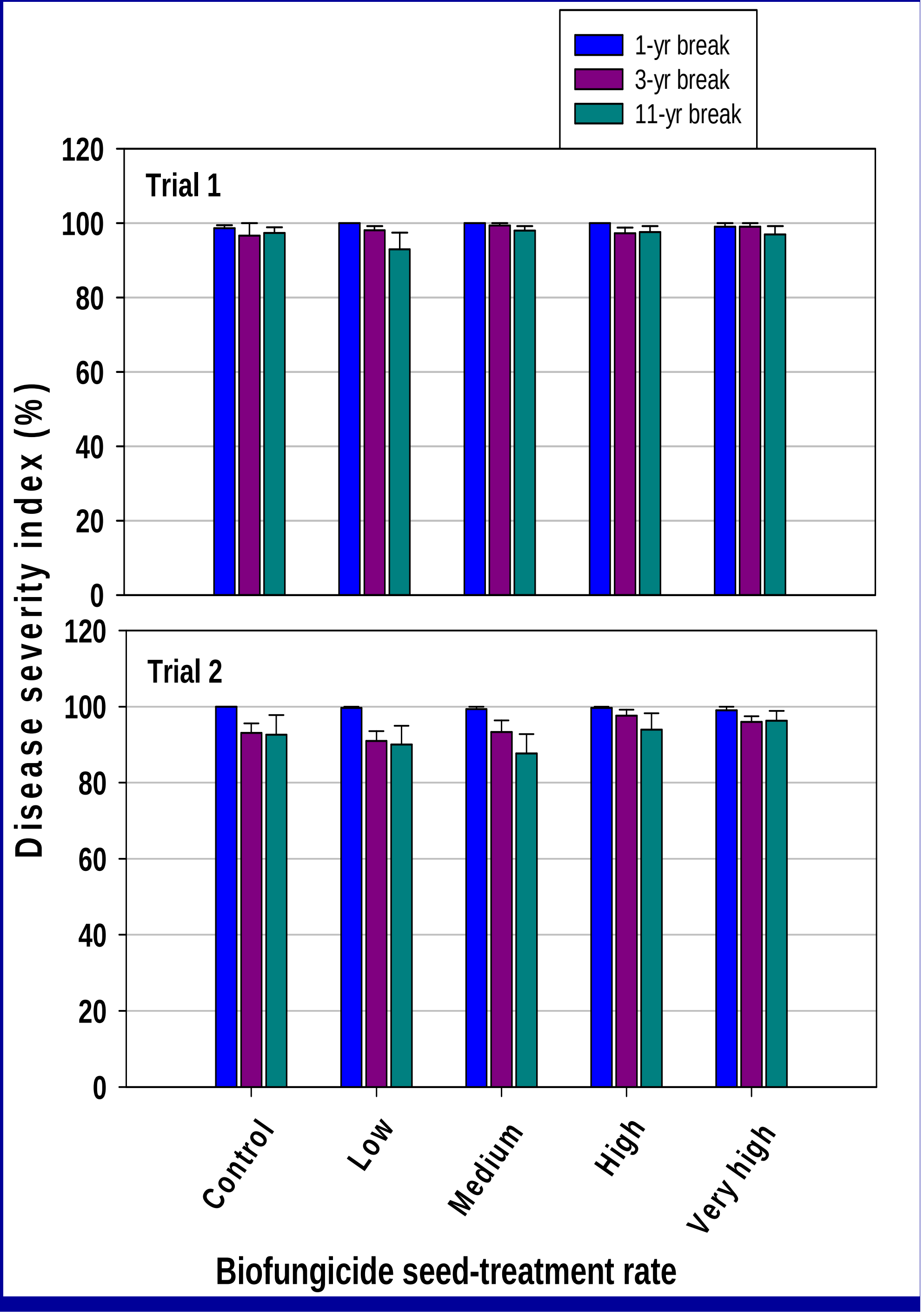
Canola – barley - Canola

3-year break

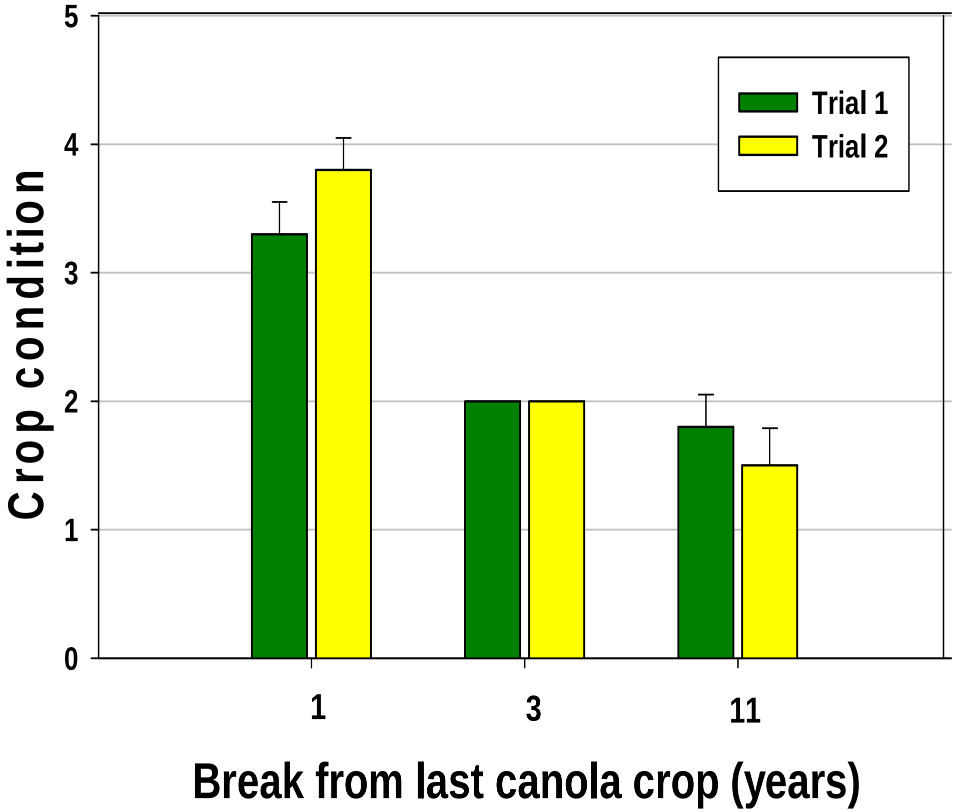
Canola-barley-barley-pea-canola

11-year break

11-years of continuous barley



Crop condition assessment

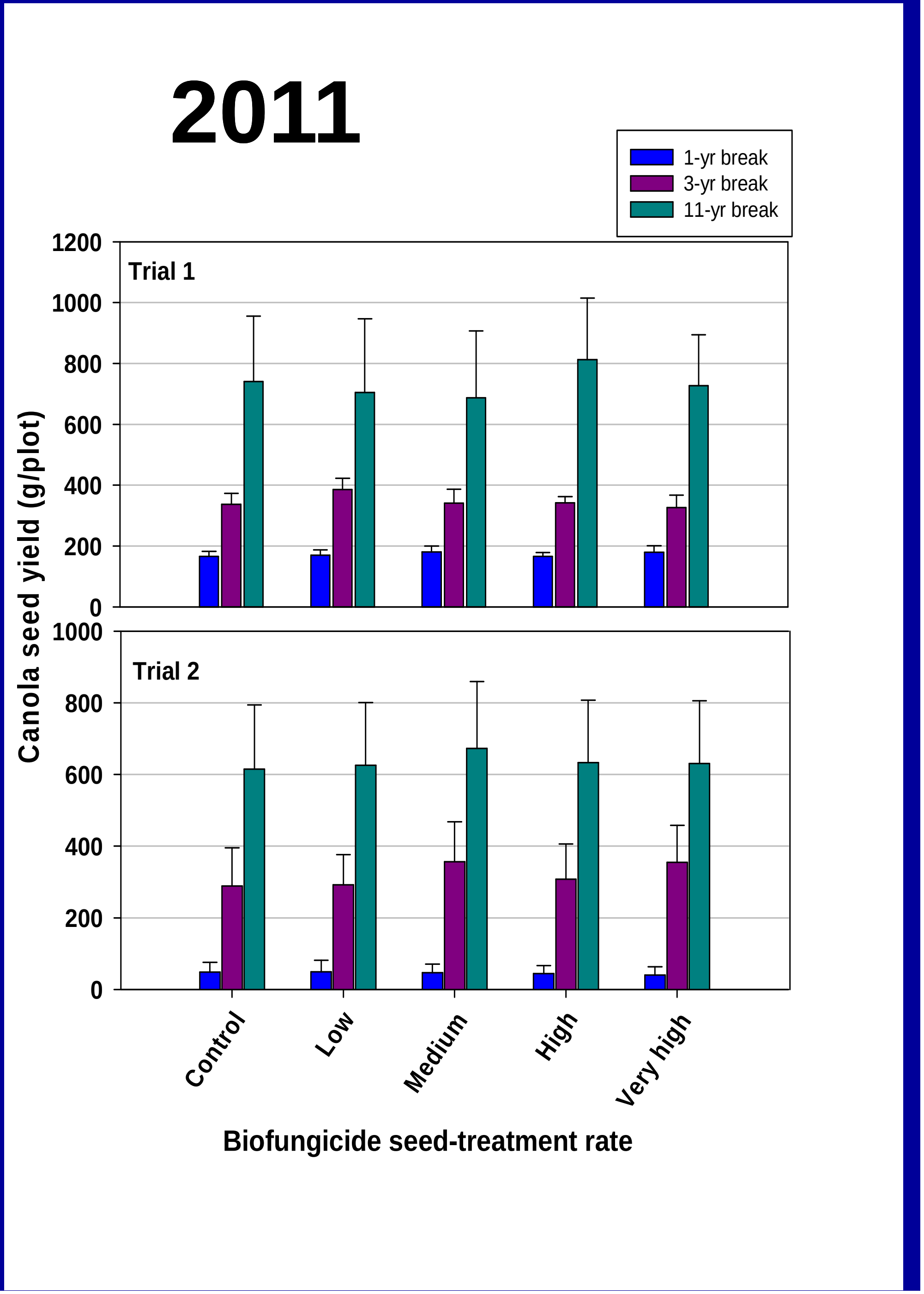


Canola seed yield

- Seed treatment was of no benefit

- A longer break from a canola crop gave much higher yields in both trials

- Even a 3-year break doubled the year relative to 1-year break due to reduced impact to the crop by clubroot



Summary

- Biofungicides/fungicides, in liquid or granule formulations, showed no efficacy against clubroot on canola under field conditions
- Resistance cultivars demonstrated high value in clubroot management, especially under high disease pressure conditions
- Long crop rotation (>4 yrs) alleviated clubroot impact on canola, reducing yield losses

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