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Survival of *Plasmodiophora brassicae* over time on the Canadian Prairies

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Clubroot in Canada

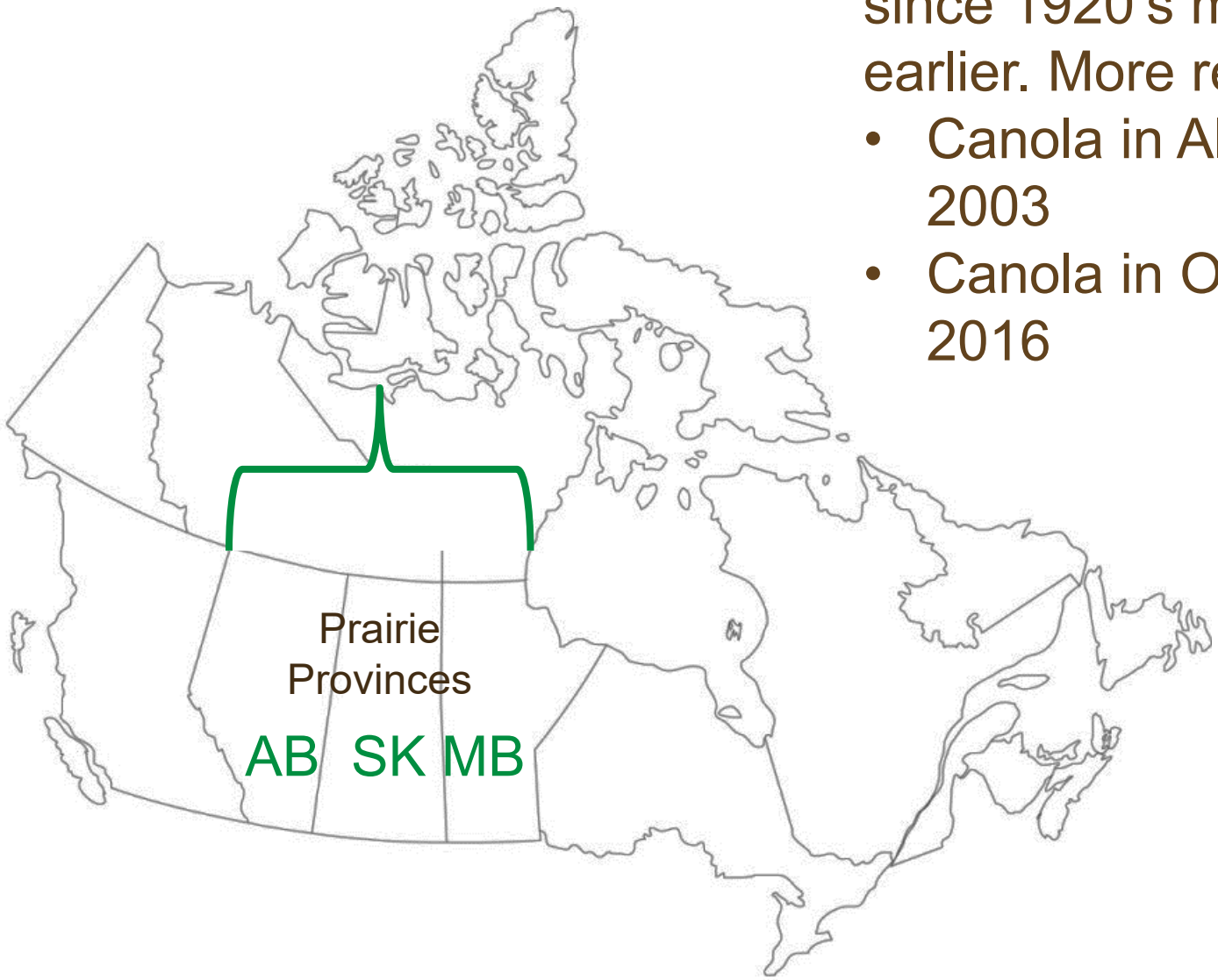
Canola production

21.4 million acres
= 8.66 m ha

18.2 million metric tonnes

Canola in the Prairie provinces

Alberta	31%
Saskatchewan	52%
Manitoba	16%



Clubroot has been endemic on vegetables since 1920's maybe earlier. More recently:

- Canola in Alberta - 2003
- Canola in Ontario - 2016

Clubroot: It's all about resting spore concentration in soil

- Conducive conditions:

  warm (17- 26 C), wet, compacted, slightly acidic (pH 5.5-6.8) soils.

- Still high disease severity under less optimum conditions when spore load is high.

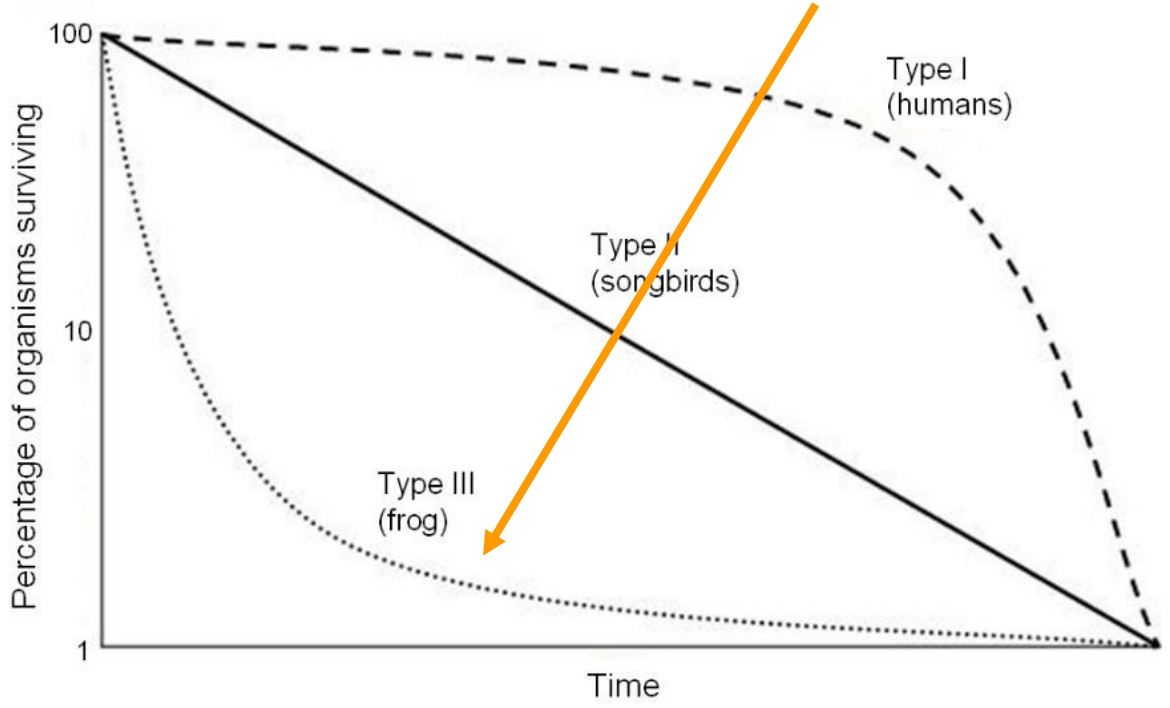
- Spore conc. ≥ 10^5 g^{-1} produce consistent infection in susceptible cultivars.

High spore concentration exacerbates problems

- In fields with high spore conc. (10^6–10^9 spores / g):
  - high disease pressure.
  - overwhelms other factors, e.g. soil amendments and pH.
  - rapid breakdown of genetic resistance.

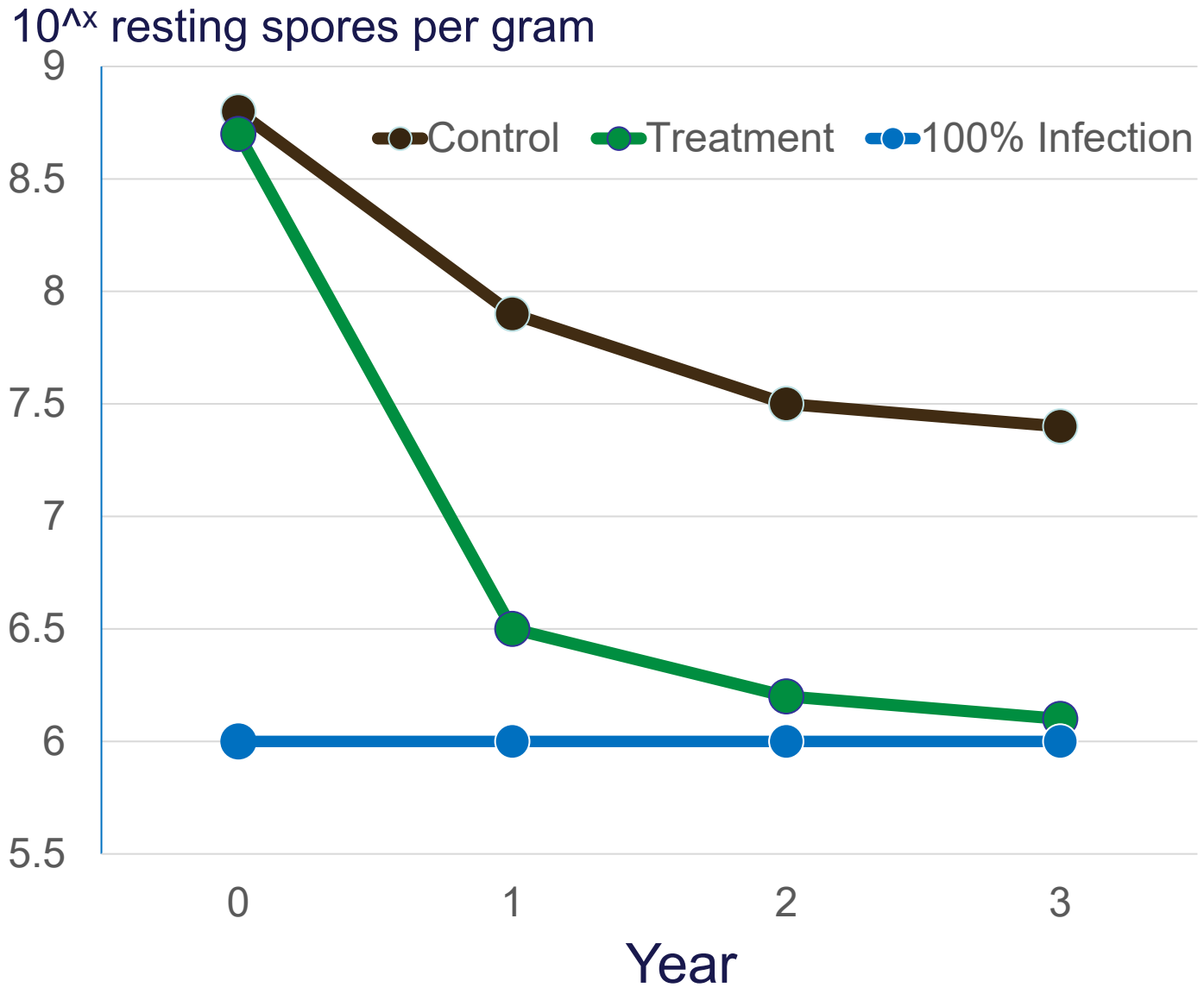
- Spores survive for many years
  - Conventional wisdom - decline is uniform.
  - Rapid reduction in first 2-3 years, then slow decline
  - Balancing selection
  - Quebec data but also Alberta results

Type III survival curve



Reduction in resting spores over time

High numbers of resting spores at the start can mean a 90% (100 to 10) reduction or 99% reduction (100 to 1) in spore concentration and still 100% disease severity in a bioassay

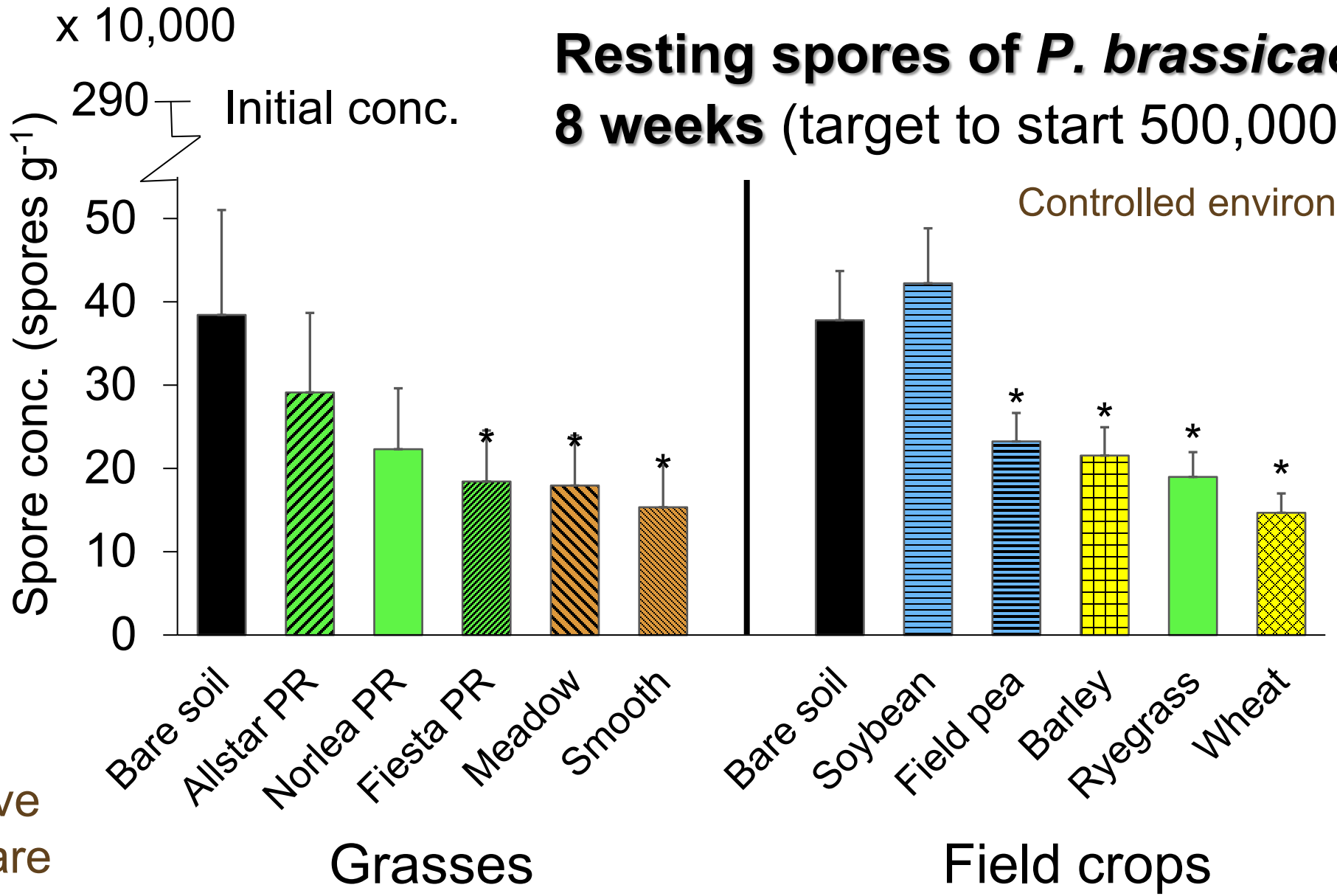


Reducing spore load

- ❑ Producers need an effective way to reduce spore concentrations and minimize movement of soil out of infested patches.
- ❑ Reducing spore numbers is difficult & expensive (e.g., fumigants)

  - ○ Lime reduces clubroot severity (inhibits spore germination?)
  - ○ Grasses increase germination and reduce spore concentration in controlled environment trials
  - ○ Grasses keep infested soil from moving
  - ○ Apply to patches, not entire fields?

Resting spores of *P. brassicae* after 8 weeks (target to start 500,000/g)



384,000 to 153,000

377,000 to 147,000

~ 60% reduction with effective grass vs bare soil

Drury et al., Plant Pathol. 2022. https://doi.org/10.1111/ppa.13601.

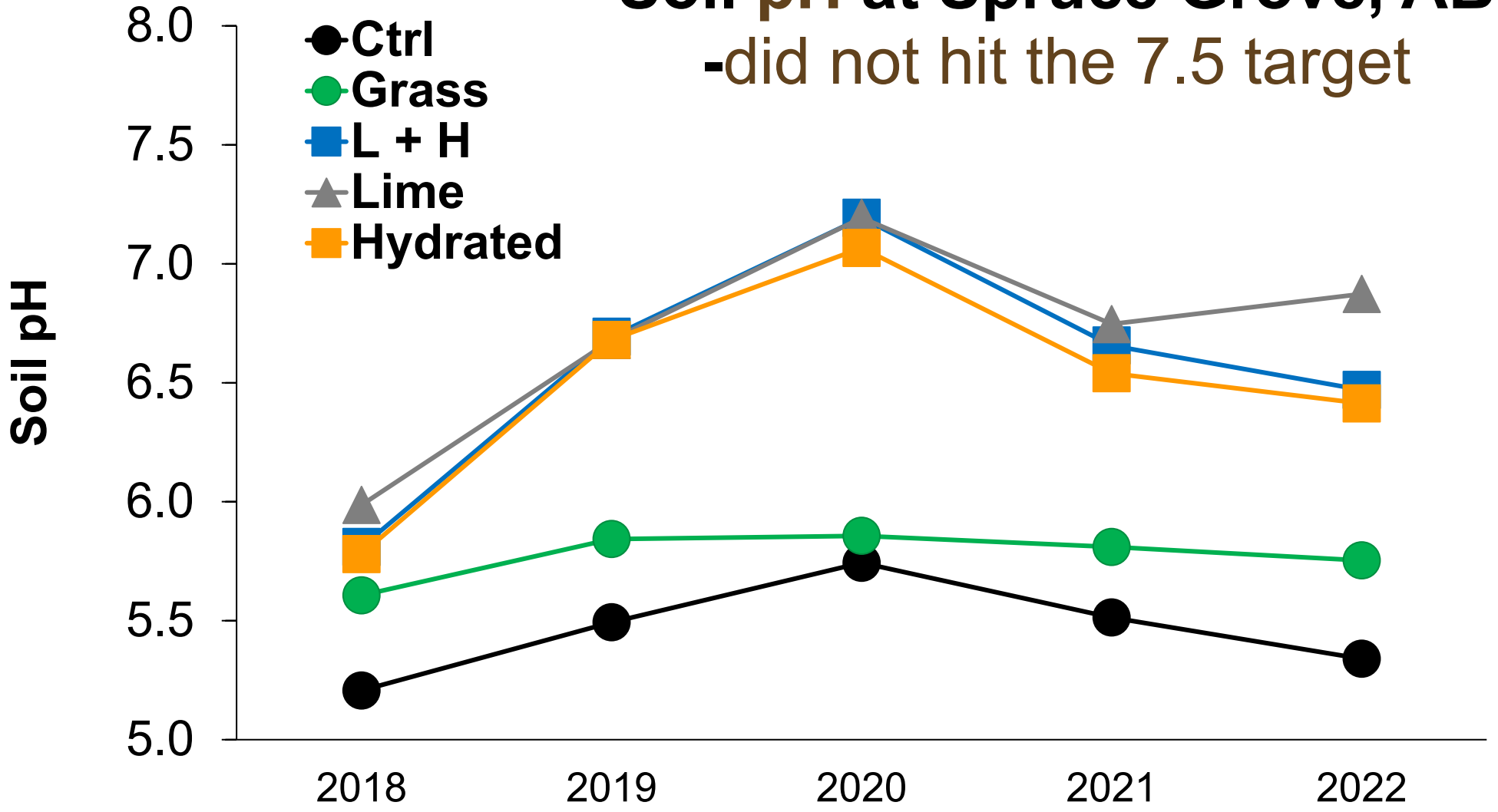
Materials and Methods- Field Trials

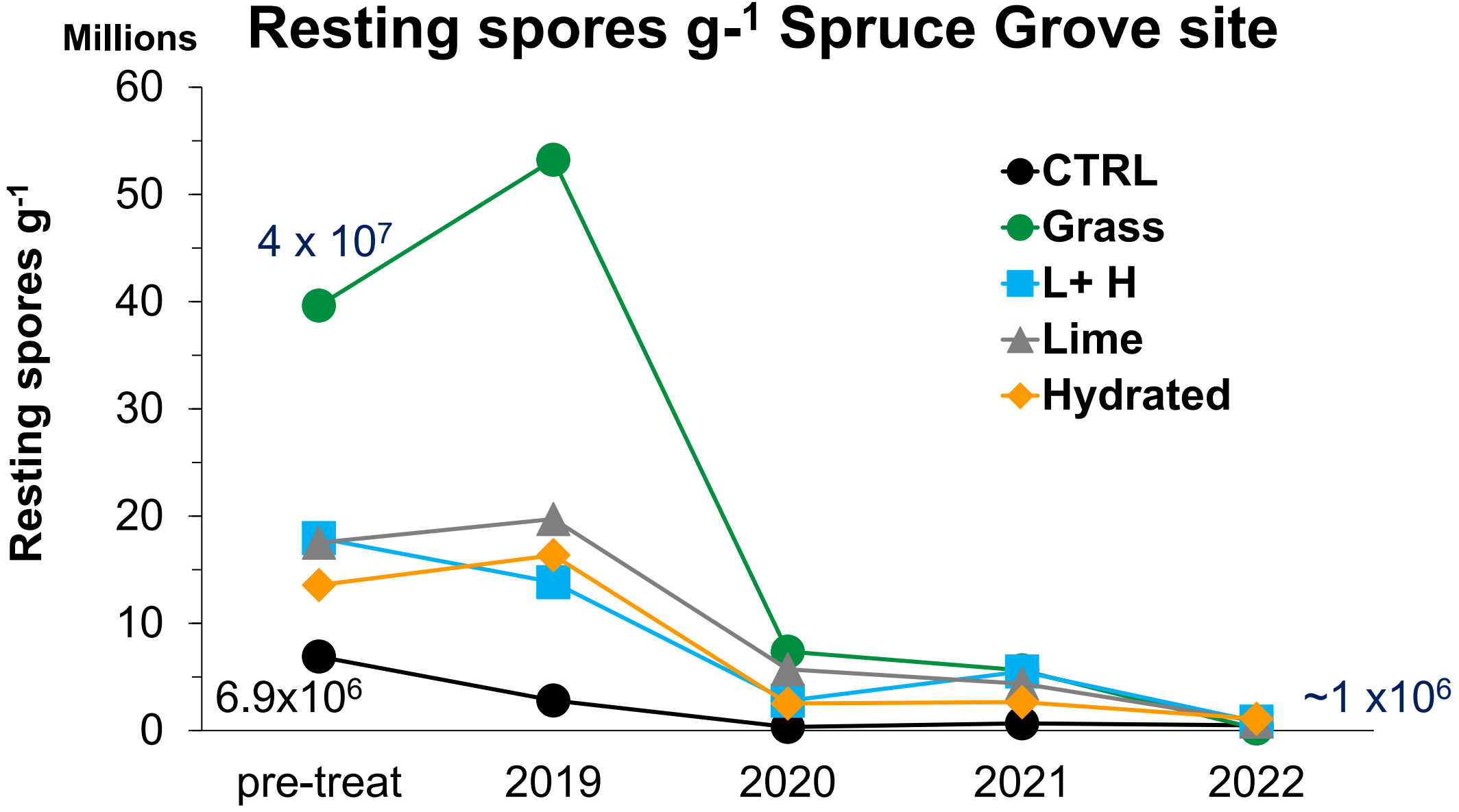
- **Five field sites**, one in Alberta, 2 in Saskatchewan and 2 in Manitoba.
- **Treatments**: bare soil (control), lime, hydrated lime, ½ L + ½ H, perennial ryegrass, plus site-specific treatments: gypsum and solarization- 2 weeks with totally impermeable film
- **Target pH** of 7.5 for lime applications.
- Two fields were acidic, three were ~neutral.
- Each trial was sampled each year, with five 15-cm cores per plot (some sites 10 cm cores).
- Spore concentration measured using ddPCR

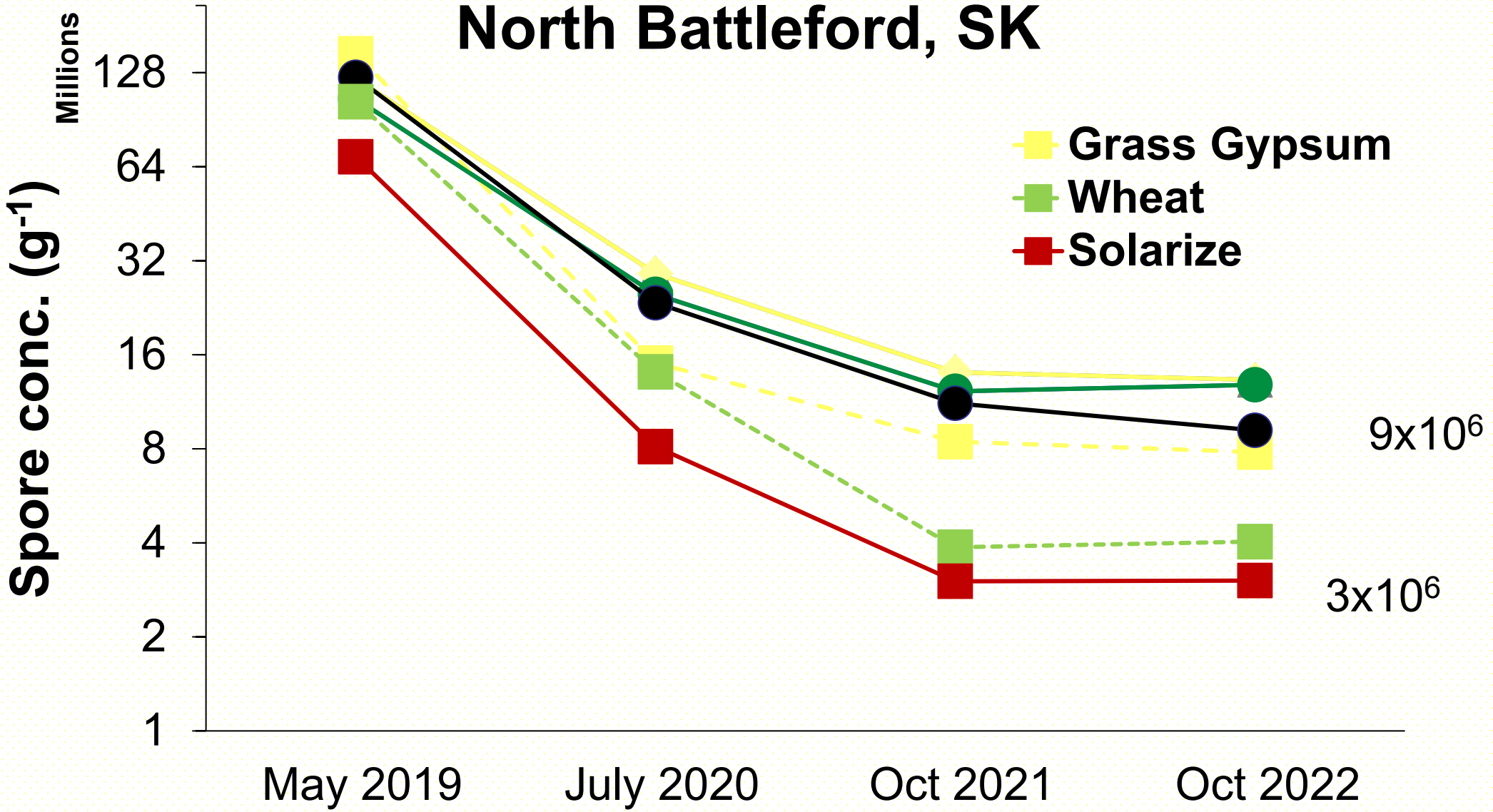
Spruce Grove, Alberta

Soil pH at Spruce Grove, AB

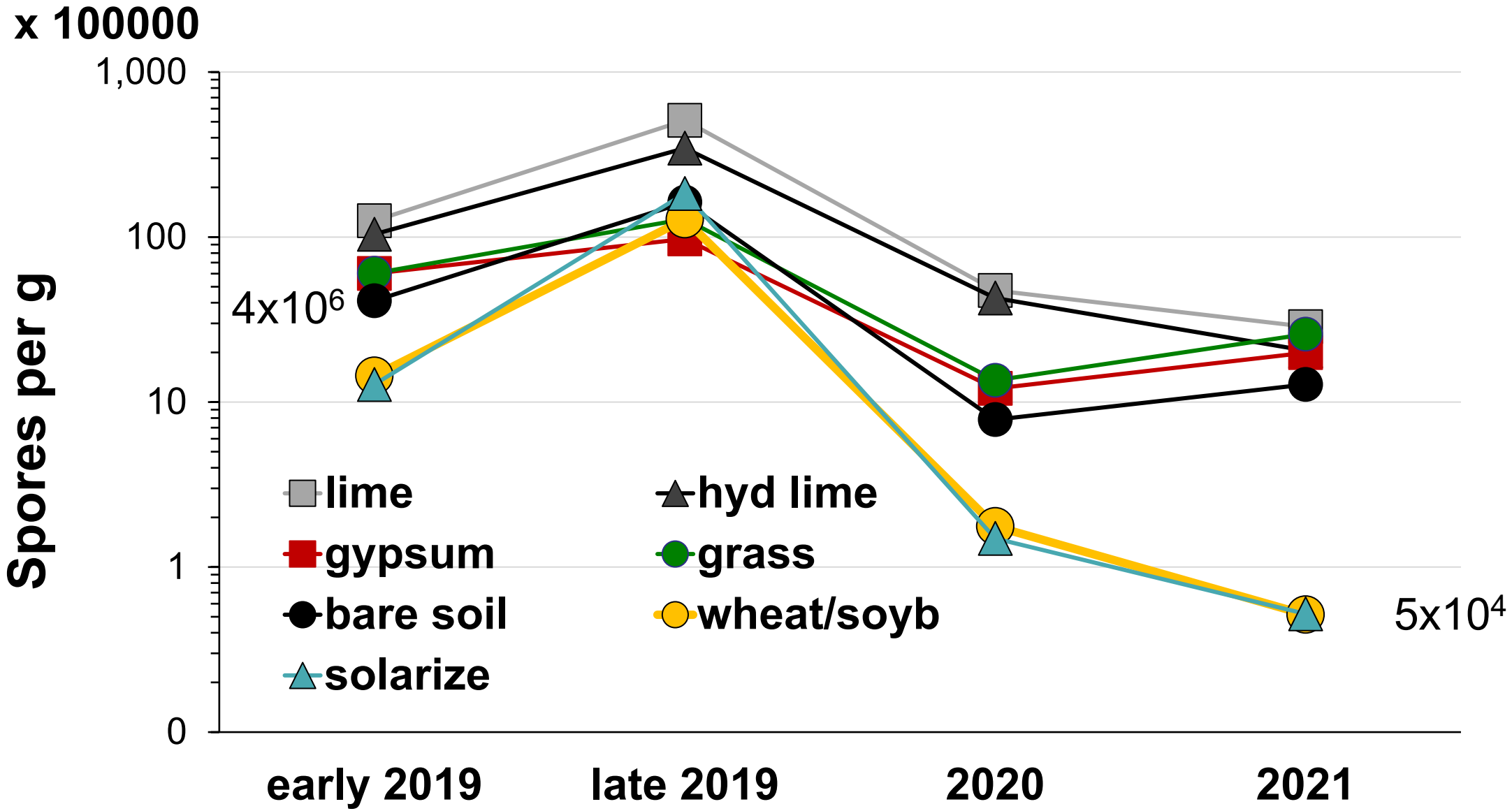
-did not hit the 7.5 target



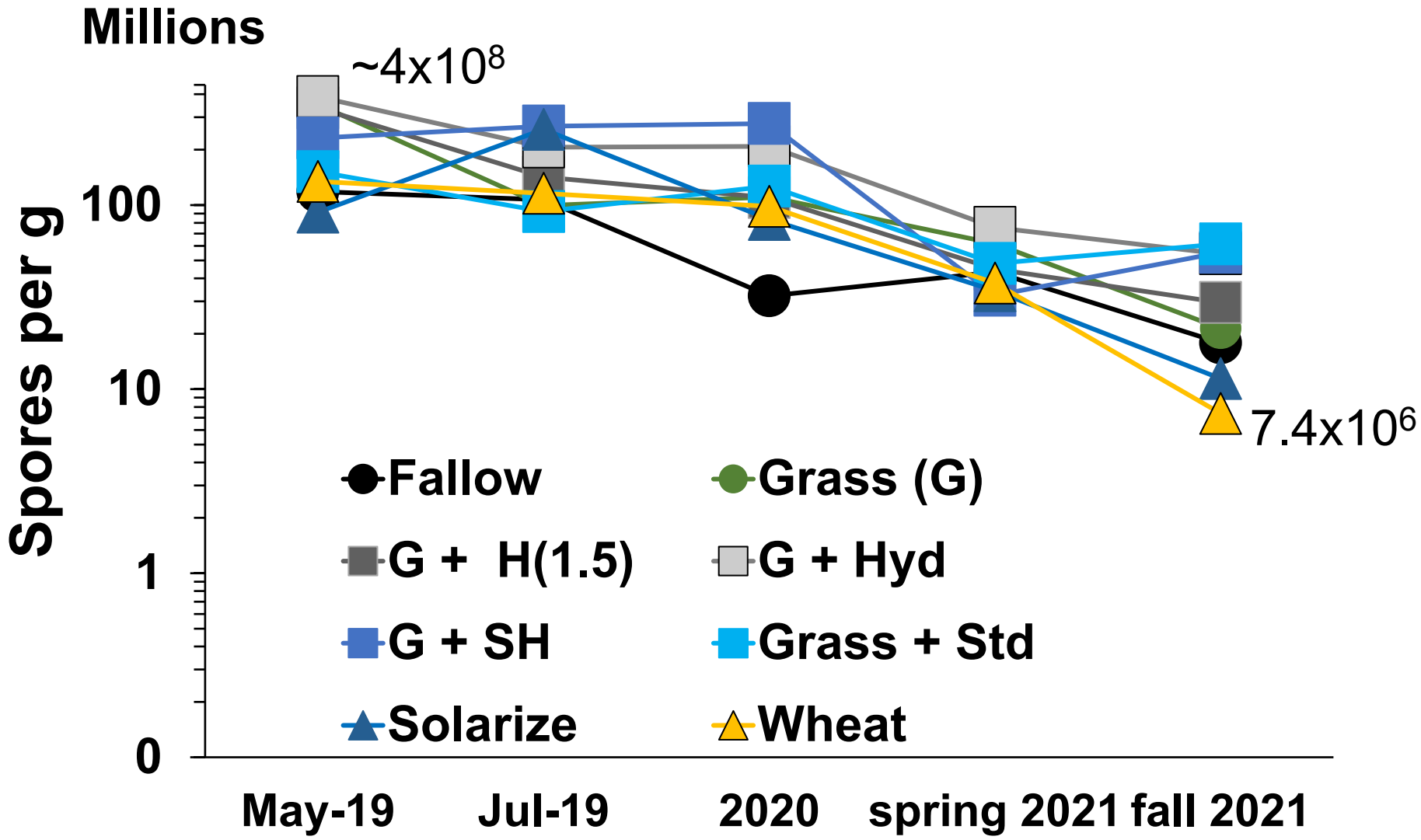

Resting spores g-1 Spruce Grove site
Millions
Resting spores g-1
60
50
40
30
20
10
0
4 x 10^7
6.9x10^6
~1 x10^6
CTRL
Grass
L+ H
Lime
Hydrated
pre-treat
2019
2020
2021
2022


North Battleford, SK
Millions
Spore conc. (g-1)
128
64
32
16
8
4
2
1
May 2019
July 2020
Oct 2021
Oct 2022
Grass Gypsum
Wheat
Solarize
9x10^6
3x10^6

Spore concentration, Kaleida MB



Spore concentration, Cutknife SK



Results and Discussion

- No consistent difference among treatments over time. Solarization looks interesting but expensive. Wheat resulted in some numerical reductions.
- Liming had no effect on spore concentration- not high enough?
- DNA concentration in the perennial ryegrass treatment was initially very high but declined sharply by 3rd yr (2020). Zoospores from infected root hairs may be adding to the *P. brasicae* DNA in soil.
- ddPCR quicker and maybe more reliable that qPCR. Both amplify DNA from dead spores.

Feng et al. 2012

Discussion

- Resting spores are not evenly distributed, even in small plots. High variation in resting spore data is common
- Most fields are no-till, so clubbed roots and released resting spores stay in place
- One club can contain up to 16 billion resting spores
- How much do resting spores leach through soil? Roots of perennial grasses may hold soil and resting spores in place, while there is more percolation of water through bare soil.
- **Recommendation**: Establish sod-forming grasses on patch to minimize spread. Consider applying lime prior to a subsequent canola crop to reduce disease pressure (resistant cv. only!). Keep growing wheat.

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Re

Questions / Comments?

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