Estimation of partial resistance in potato cultivars against *Meloidogyne chitwoodi*

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INTRODUCTION

- Potato, (*Solanum tuberosum*), represents one of the most important food plants worldwide (Spooner *et al*. 2007).
- *Meloidogyne chitwoodi* is among the nematodes of economic importance on potato.
- Damage to the crop is mainly qualitative

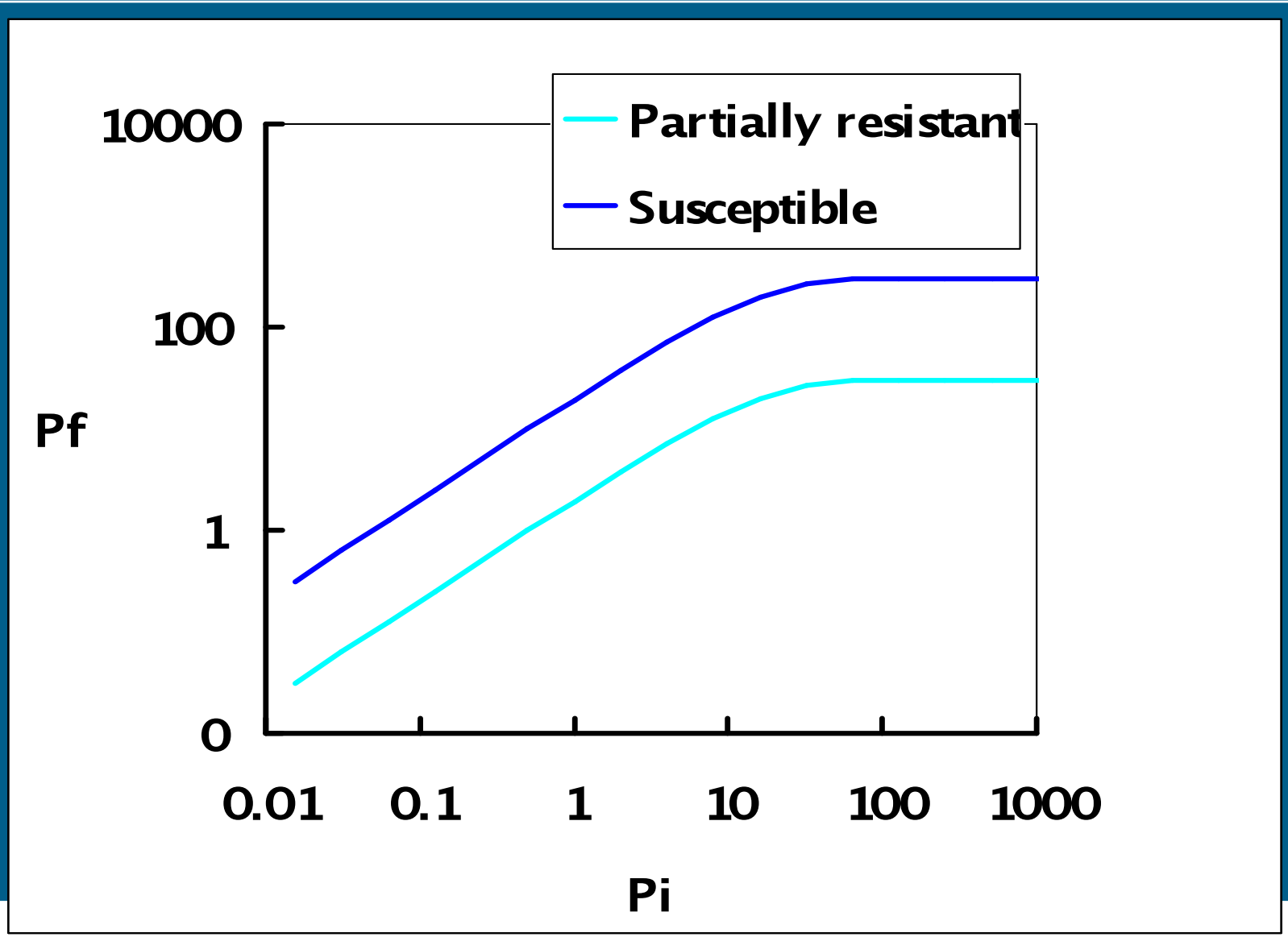
QUALITY DAMAGE

- Formation of blisters on tubers
- Development of necrotic spots around developing females in flesh
- Infections lead to rejection of tubers in both consumption and export markets

MANAGEMENT

- Seinhorst (1995) used the population dynamical model to quantify partial resistance in potatoes against *G. rostochiensis and G. pallida*
  - $Pf = M * (1 - e^{-aPi/M})$
    - *a* is maximum multiplication rate (at low nematode density)
    - *M* is maximum population density (at high nematode density)
- But can the same system work for *M. chitwoodi* ?
- Can we estimate partial resistance in the same way as was done for *G. pallida*?

Partial resistance



OBJECTIVES

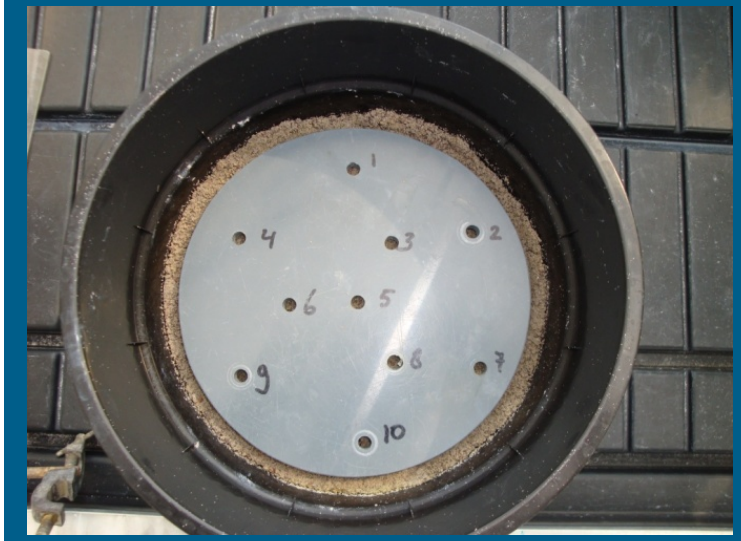
- Estimate the partial resistance of three potato cultivars bred for resistance against *M. chitwoodi*.
- Research the possibility for the development of a cheap and easy to use pot test for partial resistance testing for *M. chitwoodi*
- Investigate if the partial resistance has any impact on tuber quality

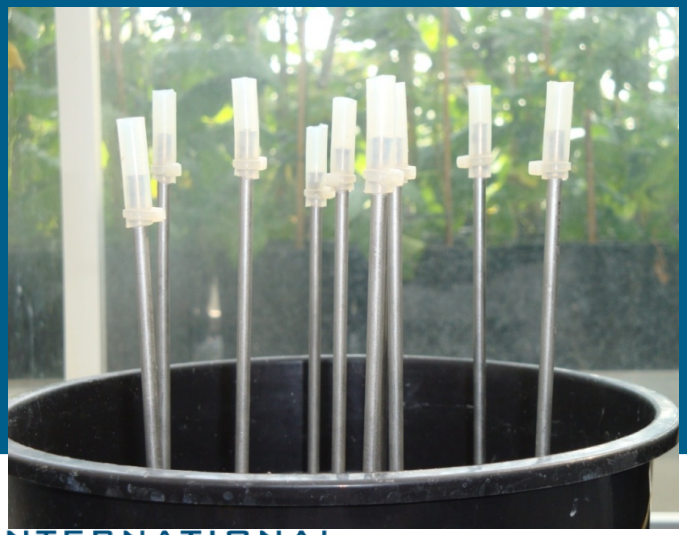
MATERIAL AND METHODS

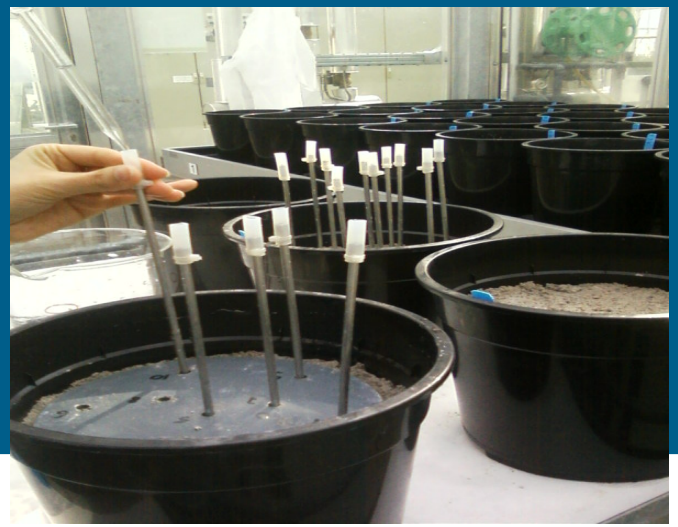
- Artificial soil (1100kg)
  - 6 liter pots, each filled with 5000g dry soil
- Nematode inoculum
  - Second-stage juveniles serve as inoculum
  - Initial Population densities ranged from 0 (control) 0.5, 1, 2, 4, 6, 8, 16, 32, 64, 128 and 256 nematodes per gram of soil.

INOCULATION

Nematodes were nearly randomly distributed in each pot







PLANT MATERIAL

- Plant materials consisted of
  - AR 04-4107
  - AR 04-4096
  - AR 04-4098
  - Desiree (susceptible check)

- Tuber pieces, each with a sprout, and about 3 cm long were used as planting materials.

GROWTH CONDITIONS

- Temperature: 15 - 20°C
- Soil moisture: 10 – 15%
- Watering: Automated
- Handling of pots: Rotated once every week

DATA COLLECTION

- Plant growth indicators
  - Plant height (weekly), Fresh root weight , Fresh and dry shoot weight, Fresh and dry tuber weight

- Final population densities in organic and mineral fractions were estimated respectively using a mist chamber and the Seinhorst elutriator

TUBER QUALITY ASSESSMENT

Root Knot Index for *Meloidogyne*

Class	Symptoms (on skin)	Egg mass (under skin)
0	None	None
1	None	Yes
2	< 30% tuber surface infection	Yes
3	30 – 100% tuber surface infection	Yes
4	Tuber heavily deformed	Yes

$$\text{RKI} = \frac{[(\#\text{ root class 0} + 1 \times 0) + (\#\text{ root class 2} \times 10) + (\#\text{ root class 3} \times 33) + (\#\text{ root class 4} \times 100)}{\text{Total number of root assessed}}$$

MODELING AND PARAMETER ESTIMATION

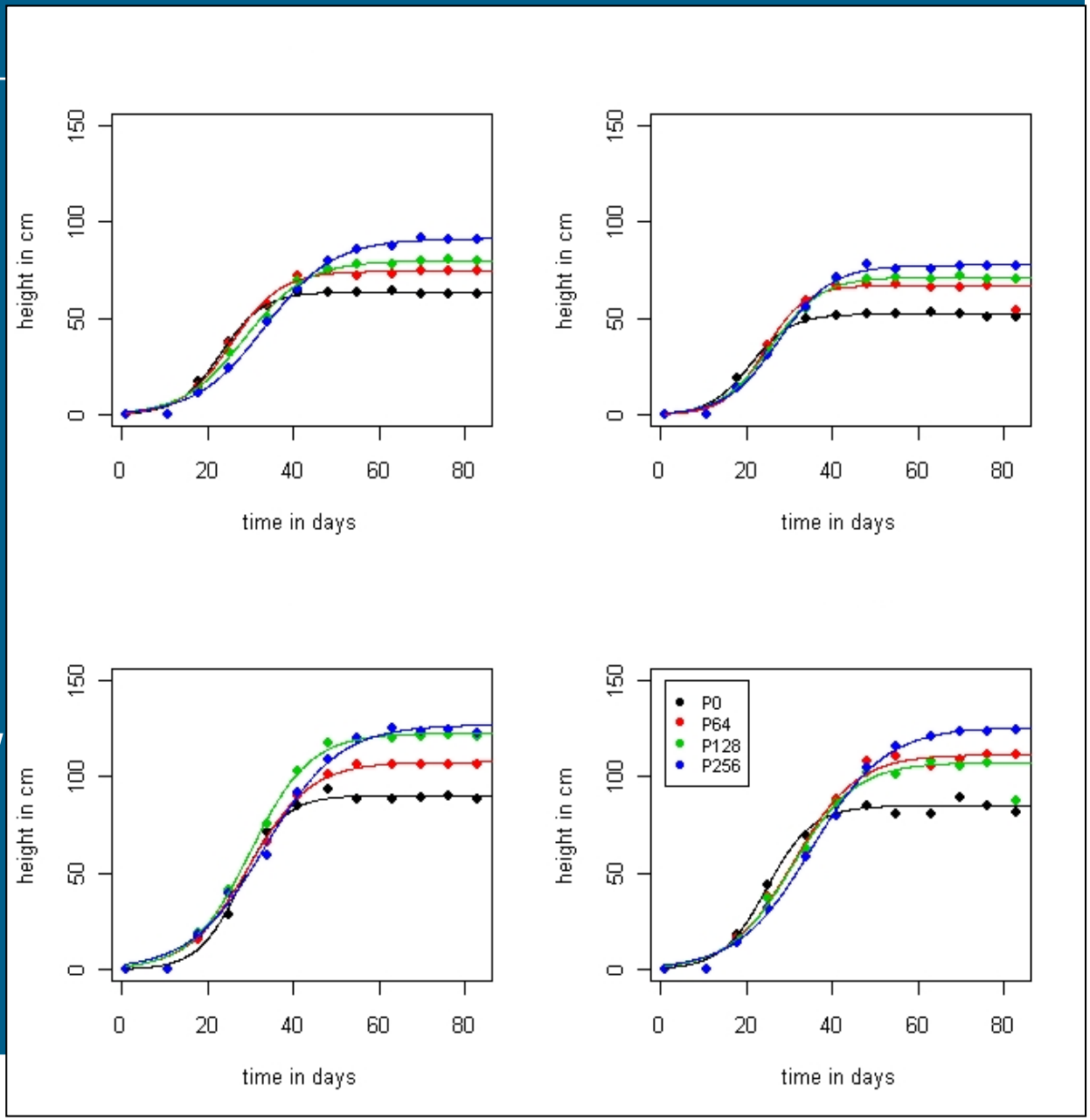
- Models used:
  - Logistic model fitted to plant height in time
  - Seinhorst (1986) model to fresh tuber and total fresh weight
  - Seinhorst (1967) model for population development
- All models were fitted using non-linear least square regression. Models were fitted using R.

RESULTS

Plant height

- Growth curves after emergence were typically logistic for all cultivars

- Infected plants grew taller



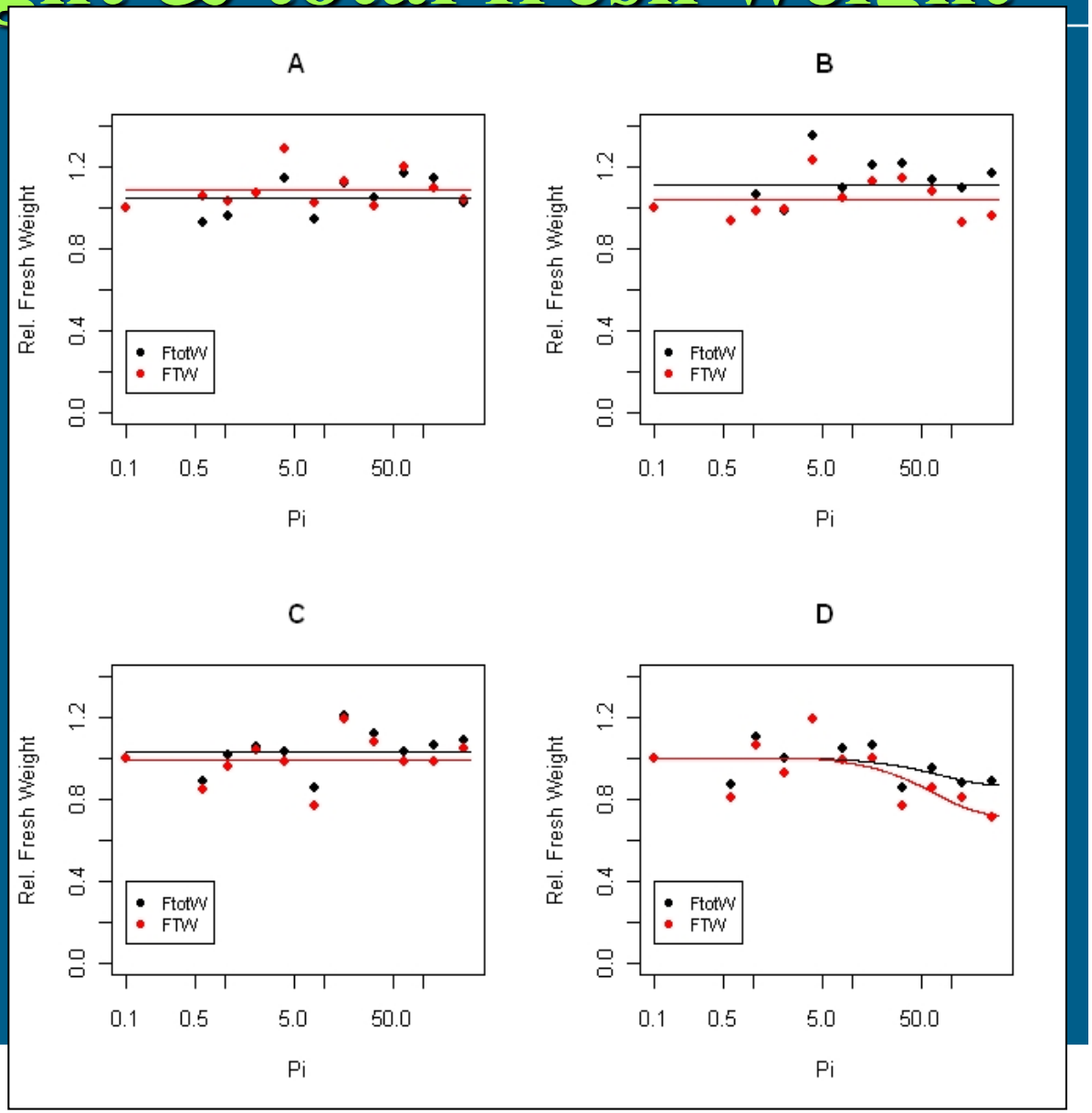
Fresh tuber weight & total fresh weight

Fresh tuber weight

Cultivar	*m*	*T*
AR 04-4107	1	-
AR 04-4096	1	-
AR 04-4098	1	-
Desirée	0.86	3.5 juv/gsoil

Total fresh weight

Cultivar	*m*	*T*
AR 04-4107	1	-
AR 04-4096	1	-
AR 04-4098	1	-
Desirée	0.72	3.5 juv/gsoil



Parameter values Pop. Dynamical model

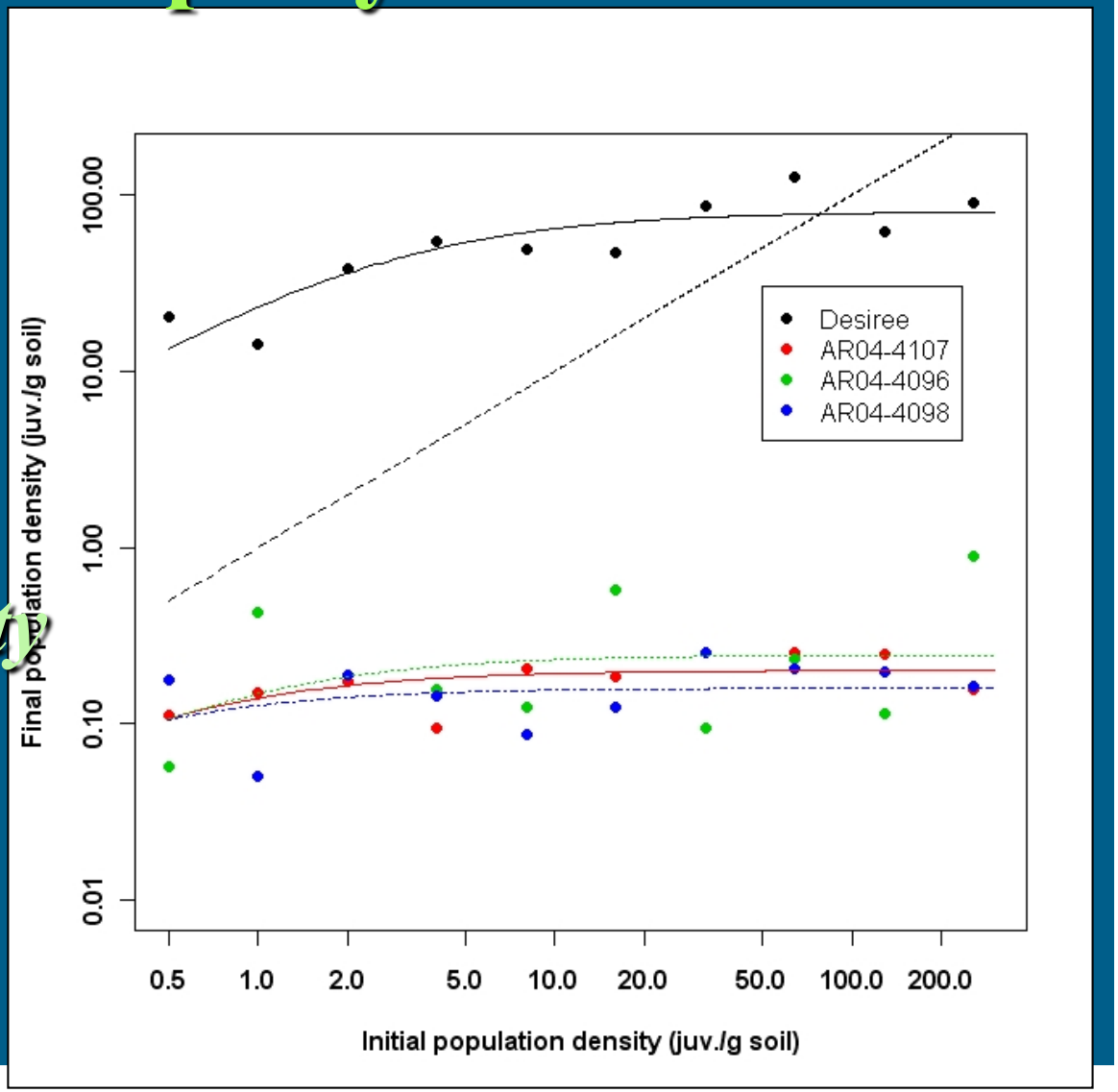
Parameter estimates

Cultivar	*a*	*M*
AR 04-4107	0.55*	0.16*
AR 04-4096	0.27*	0.18*
AR 04-4098	0.91*	0.10*
Desirée	32	80

* Significantly different at $P = 0.05$

Relative Susceptibility

Cultivar	rs_a	rs_M
AR 04-4107	1.7	0.2
AR 04-4096	0.8	0.2
AR 04-4098	2.8	0.1
Desirée	100	100



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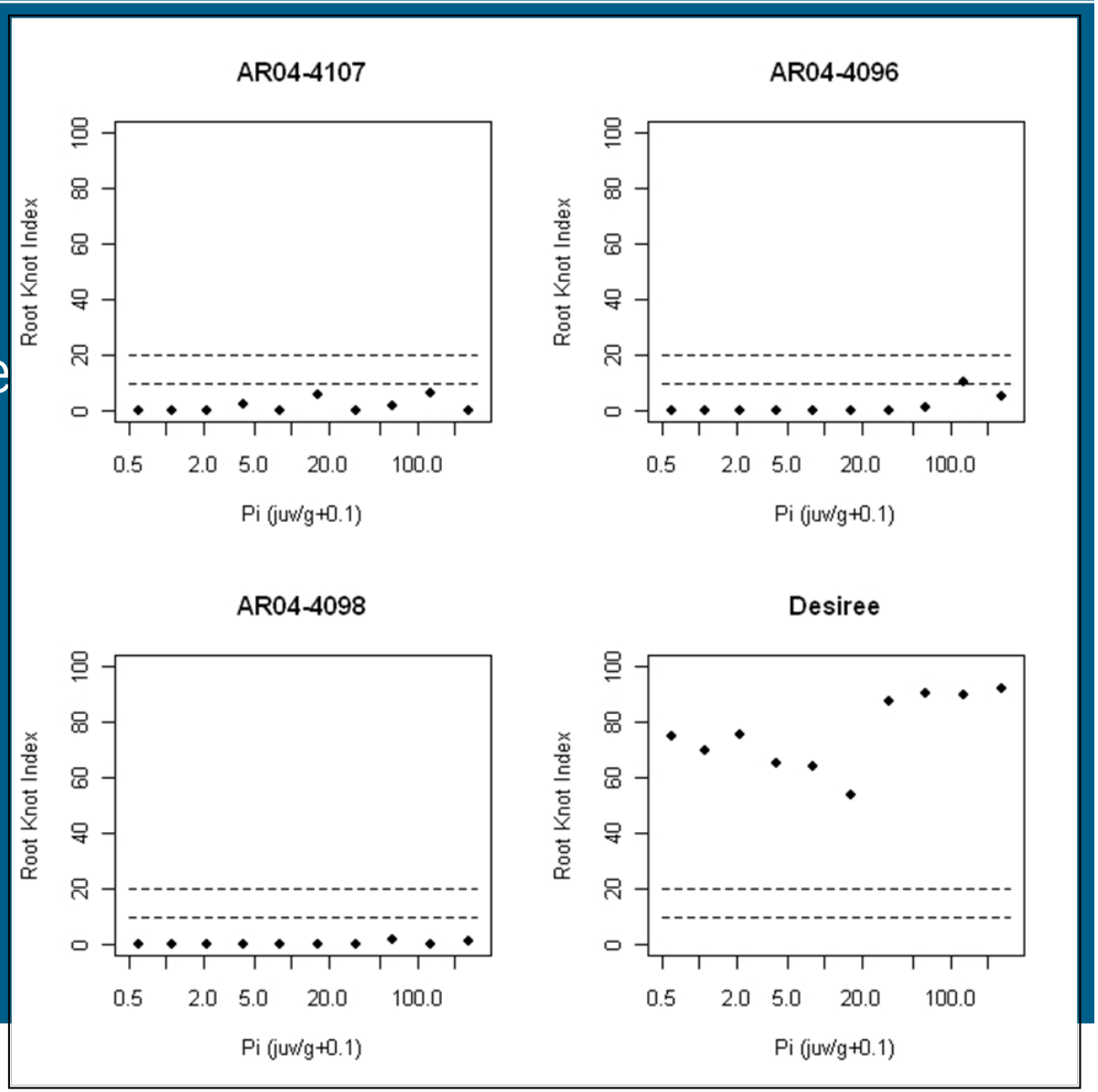
Tuber quality based on root-knot index

Ware potatoes

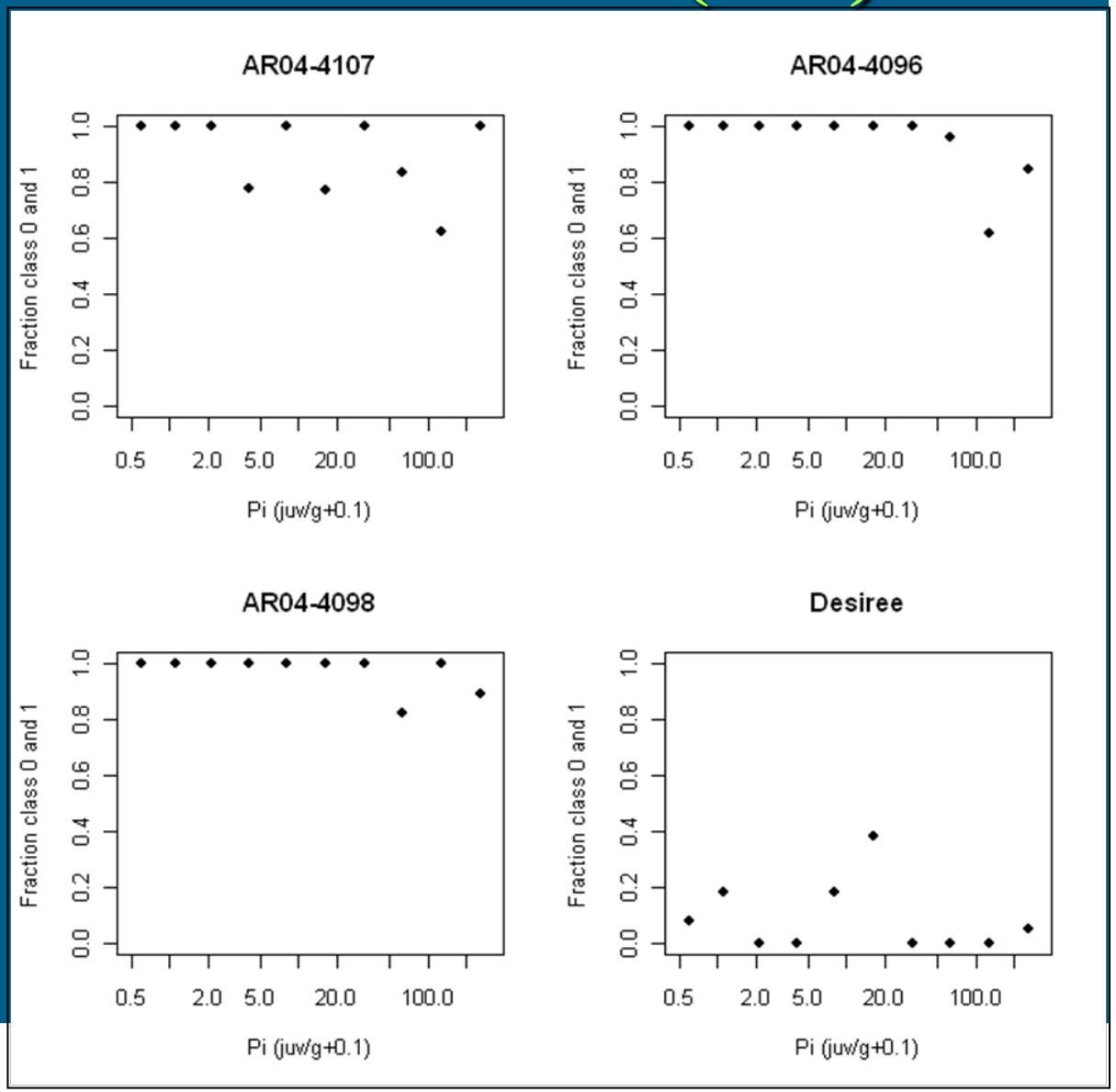
- At all densities tested, the new cultivars maintained tuber quality below the RNI=10 lower quality threshold.



Quality based on class 0 and 1 (EU)

Seed potatoes

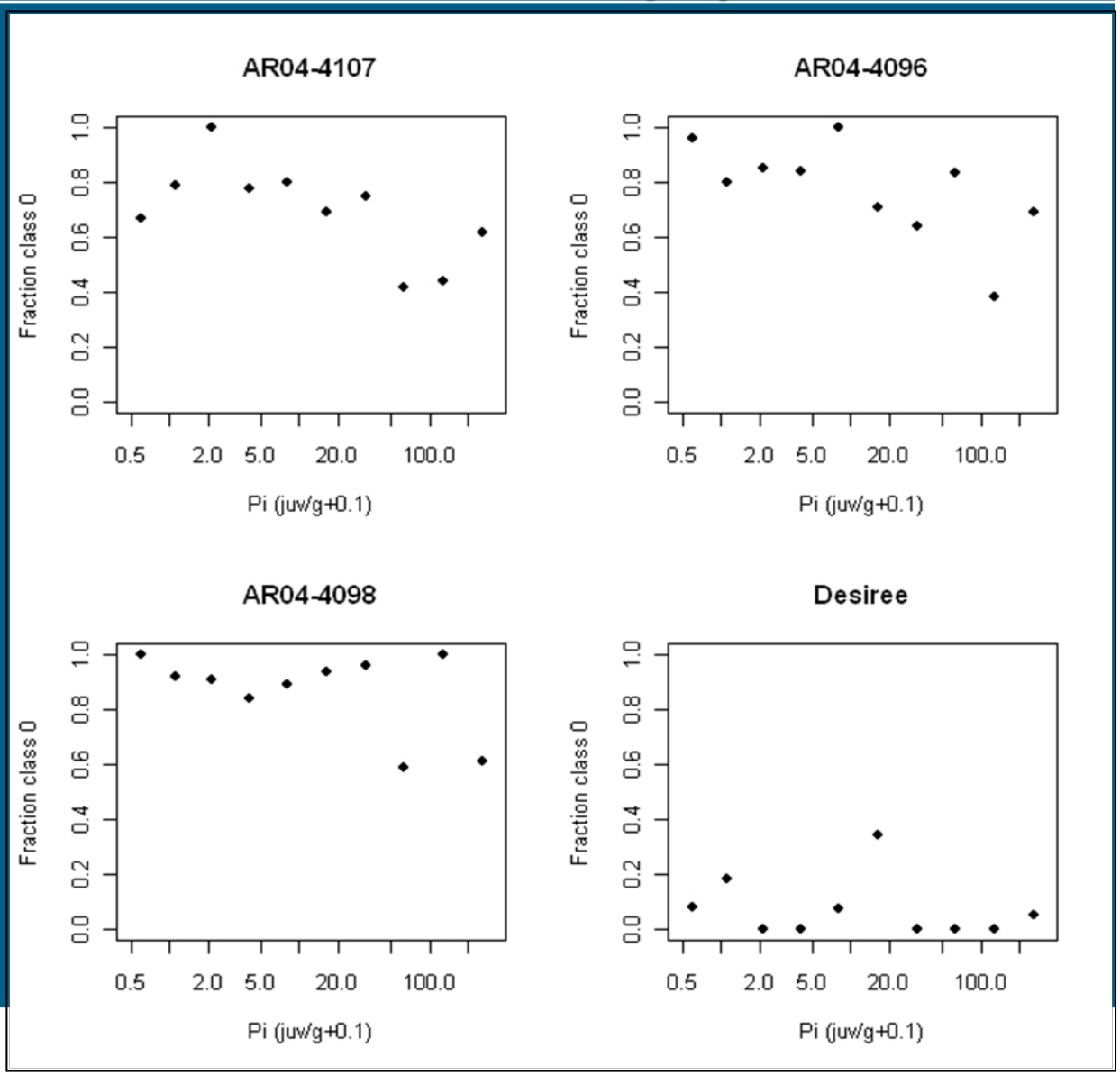
- AR 04-4098 and AR 04-4096 both had same damage threshold of 32 juveniles/g soil.
- AR 04-4107 was more vulnerable to quality losses and had a damage threshold of 2 juveniles/g soil.



Quality based on class 0 (free of external *and* internal symptoms)

Seed potatoes

- The three resistant cultivars gave quality damage threshold at *Pi* 0.5 juv/g soil.



Discussion

- The inclusion of a single resistance gene against *M. chitwoodi* resulted in
  - a high partial resistance
  - resistance was associated with tolerance for yield reduction.

- Going by current regulations, our materials could be accepted as ware or industrial potatoes (e.g. chips, French fries) provided quality is sustained during storage

Discussion

- Acceptance as seed potatoes
  - We may have problems accepting these cultivars because the estimated resistance could not yield tubers completely free of internal symptoms.
  - Population within these tubers could just increase over time.
  - Molecular test are more frequently used

Discussion

- Results are encouraging but feasibility of routine testing needs more basic research
  - Our materials were highly partially resistant
  - Only one population of the M. chitwoodi evaluated
  - Tuber quality was assessed at harvest hence, no idea of population build-up during storage

- The way forward
  - Need to include more plant material and populations in the test
  - Understand the effects of storage on tuber quality and population development in the tubers
  - Establish the relation between RS and tuber infestation

THE END

- Thanks to:
  - VLIR
  - Annelies Beniers
  - Ralph Post
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- I APPRECIATED YOUR ATTENTION!!