

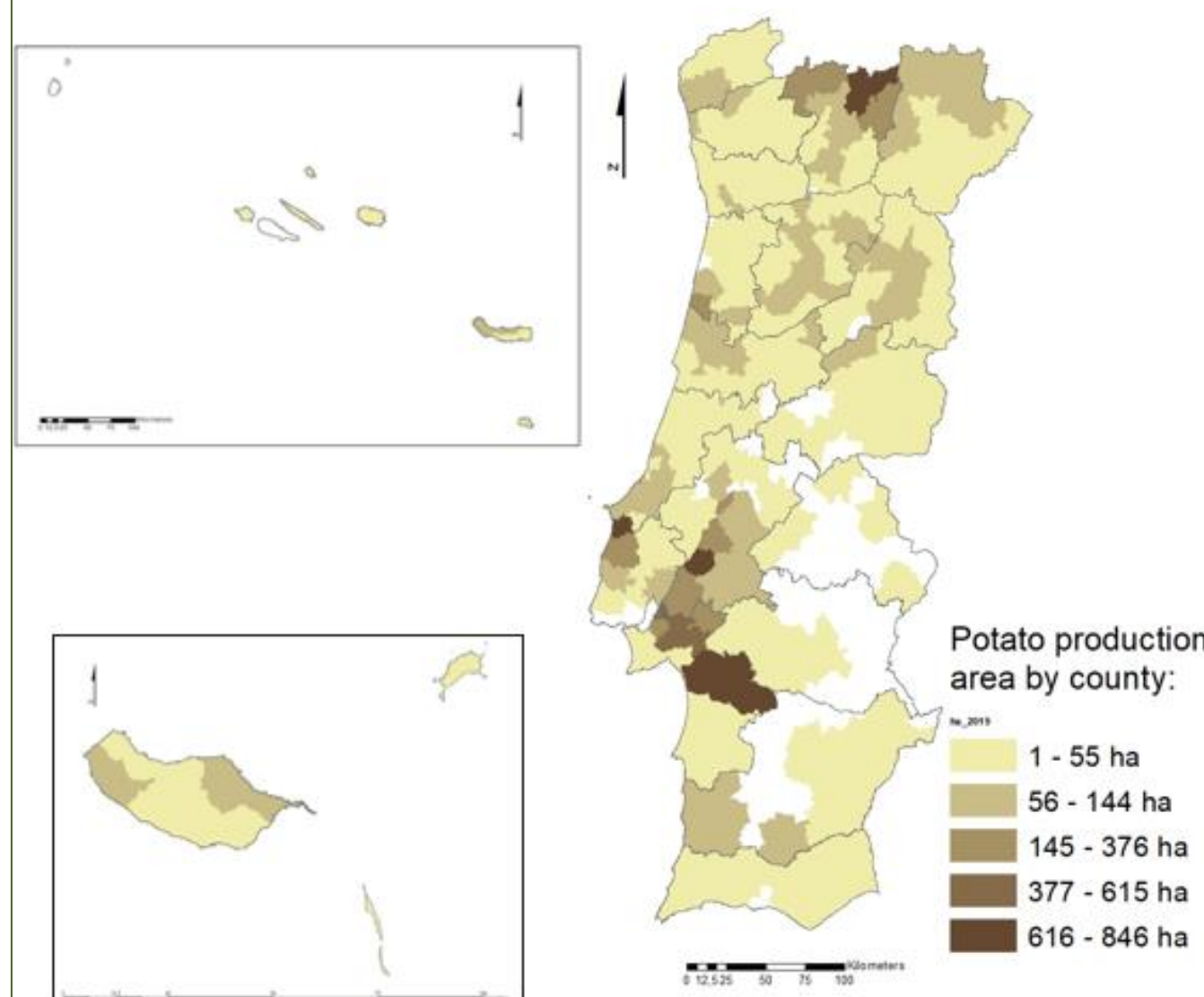
Potato cyst nematodes in Portugal: geographical distribution and integrated pest management outcomes

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Portuguese potato production



In Portugal, potato crop is grown throughout the territory, including Madeira and Azores archipelagos

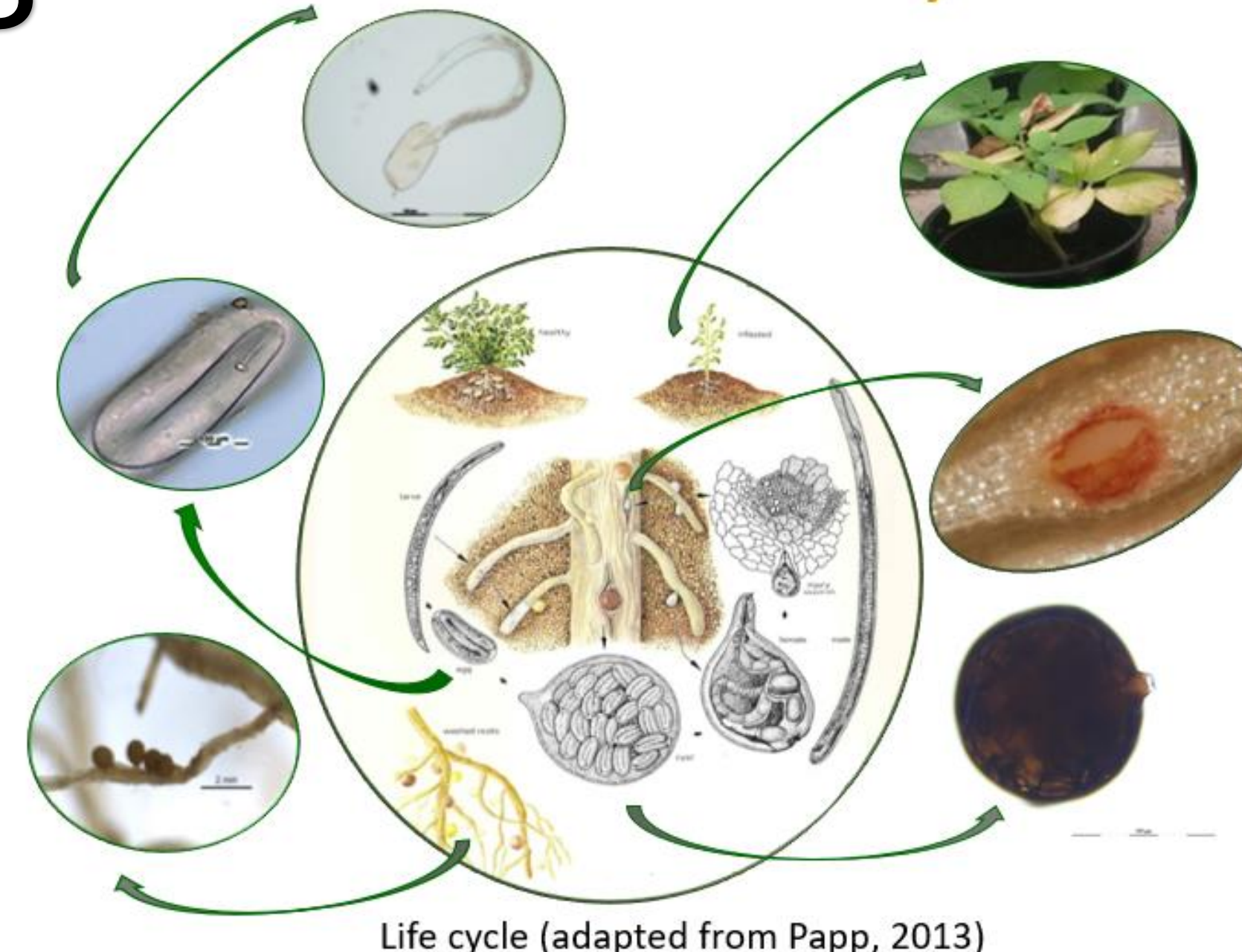


Potato production in Portugal:

- 490.724 tonnes
- 13.383 ha
- 92% as main monoculture

Agricultural Censos - 2019 (INE, 2021)

Potato cyst nematodes



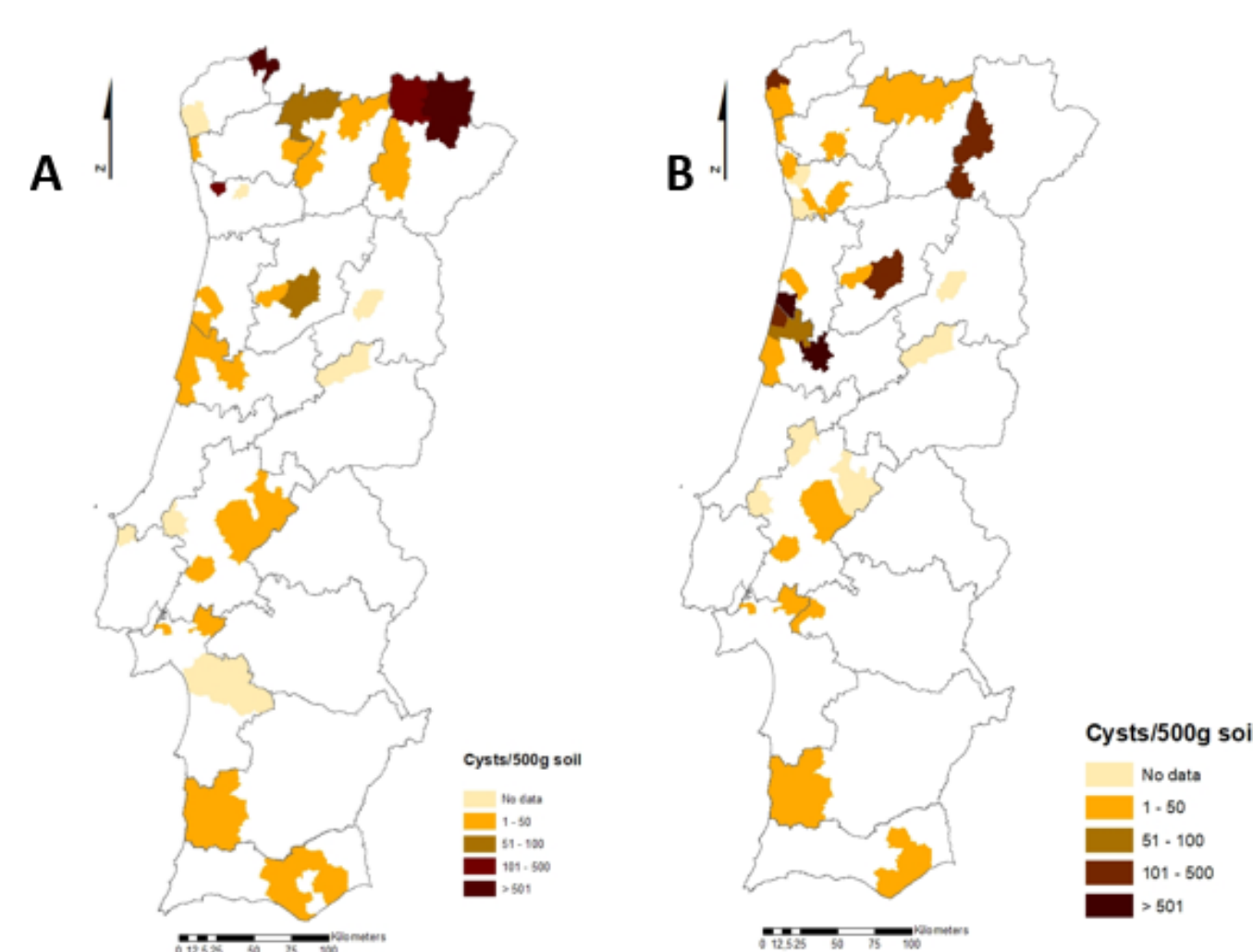
Potato cyst nematodes (PCN), *Globodera rostochiensis* and *G. pallida*, are quarantine organisms and are subject to stringent regulatory measures when detected singly or in combination (EPPO, 2017).

PCN are sedentary endoparasites of potato root system and deteriorate the quality and commercial value of tubers.

The main symptoms are yellowing of leaves and reduced yields due to nutrients deficiency caused by PCN parasitism.

Yield losses due to the presence of PCN can vary from slight losses, reaching up to crop failure depending on the infestation level (Lima *et al.*, 2018).

PCN detection



Portuguese counties with positive detections of *Globodera rostochiensis* (A) and *Globodera pallida* (B) between 2013 and 2020

Z-test for the equality of two proportions

•Species detections are significantly different

(H0:G_r=G_p; H1:G_r≠G_p; p-value=0.00014, α=0.05)

• *G. pallida* detection being greater than *G. rostochiensis* detection

(H0:G_p≥G_r; H1:G_p<G_r; p-value=0.999, α=0.05)

• Northern PCN detection is greater than the Center PCN detection

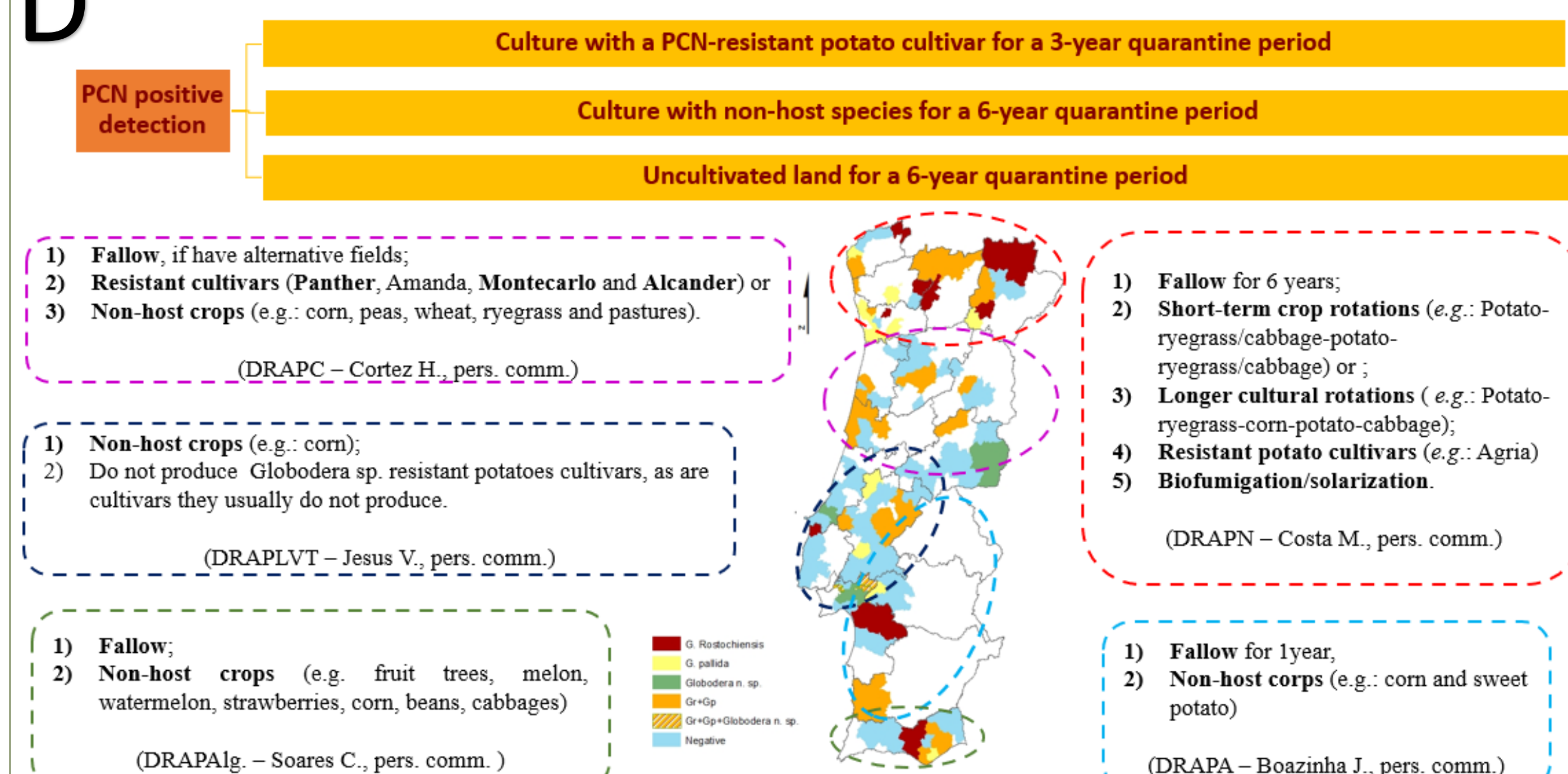
(H0:N≥C; H1:N<C; p-value=0.998, α=0.05)

• Center PCN detection is greater than the Southern (Lisbon and Tagus Valley, Alentejo and Algarve regions) PCN detection

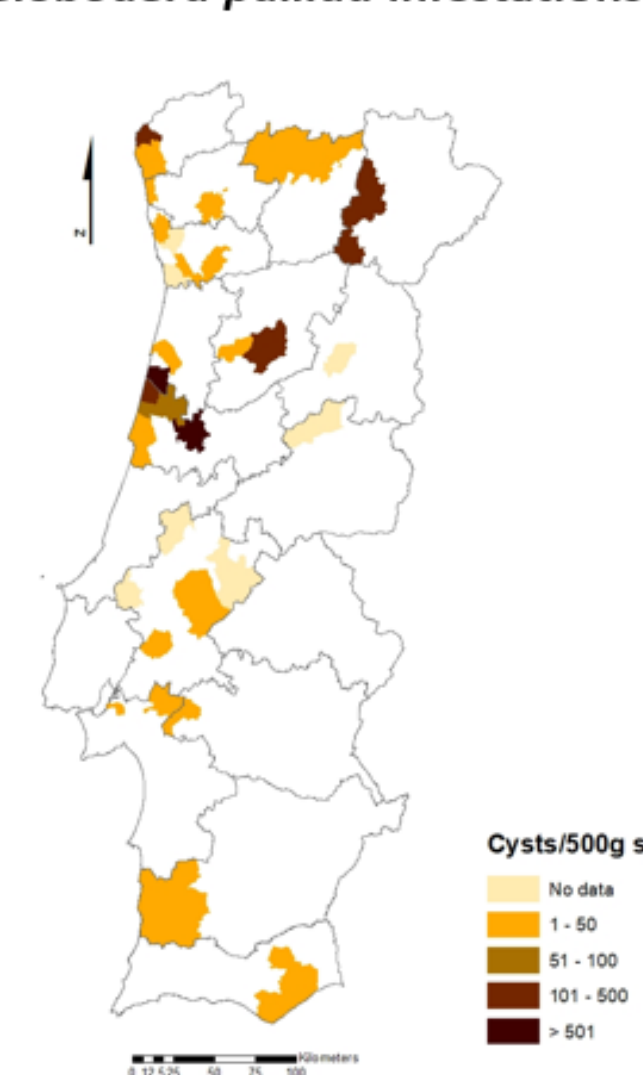
(H0:C≥S; H1:C<S; p-value=1, α=0.05)

PCN detection increases from south to north

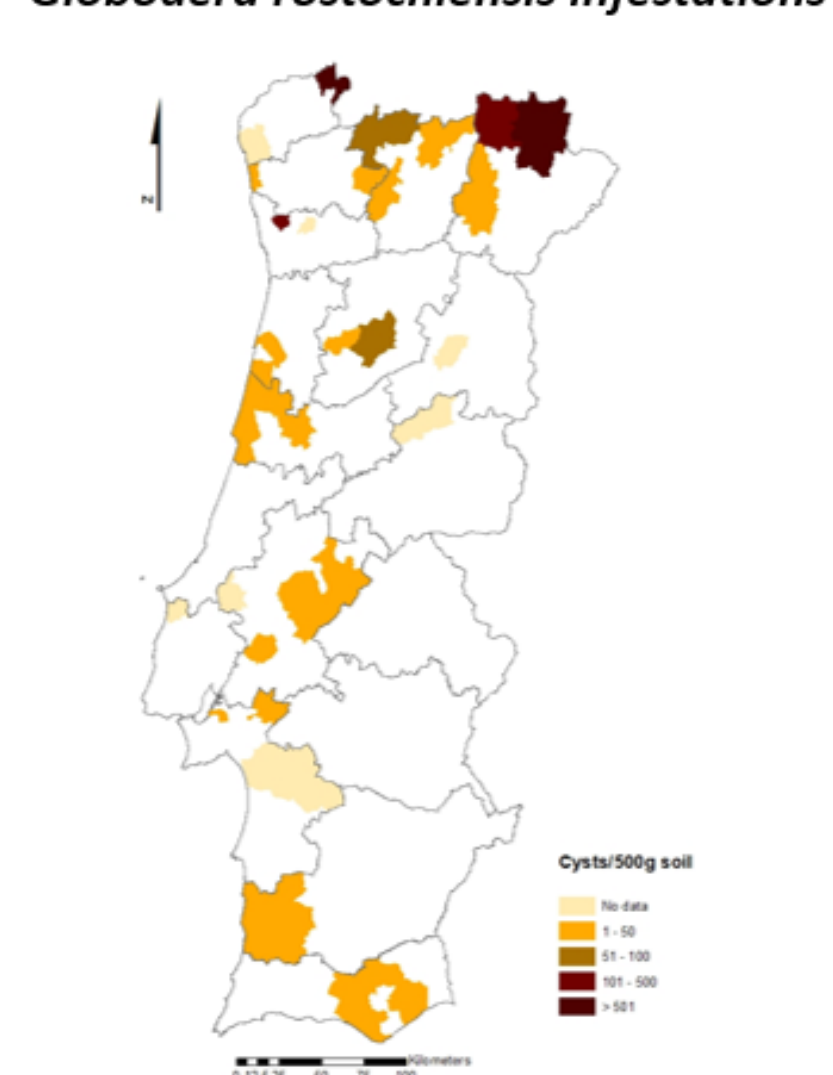
Phytosanitary control measures



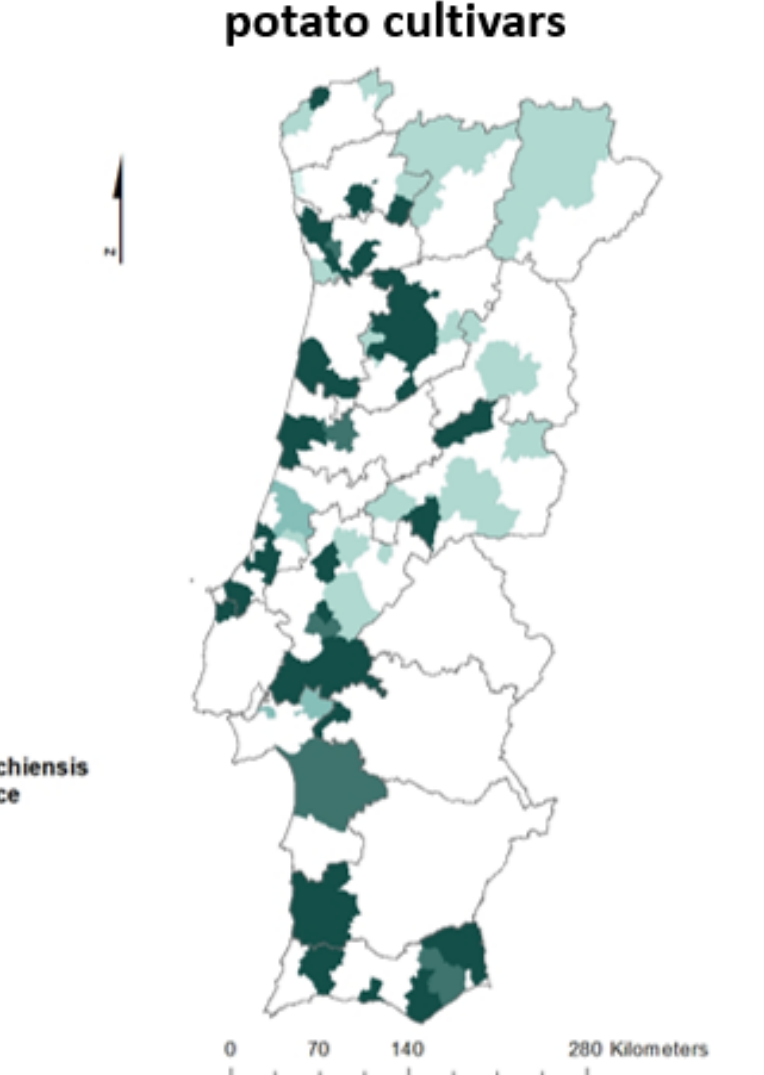
Globodera pallida infestations



Globodera rostochiensis infestations



Globodera rostochiensis resistant potato cultivars



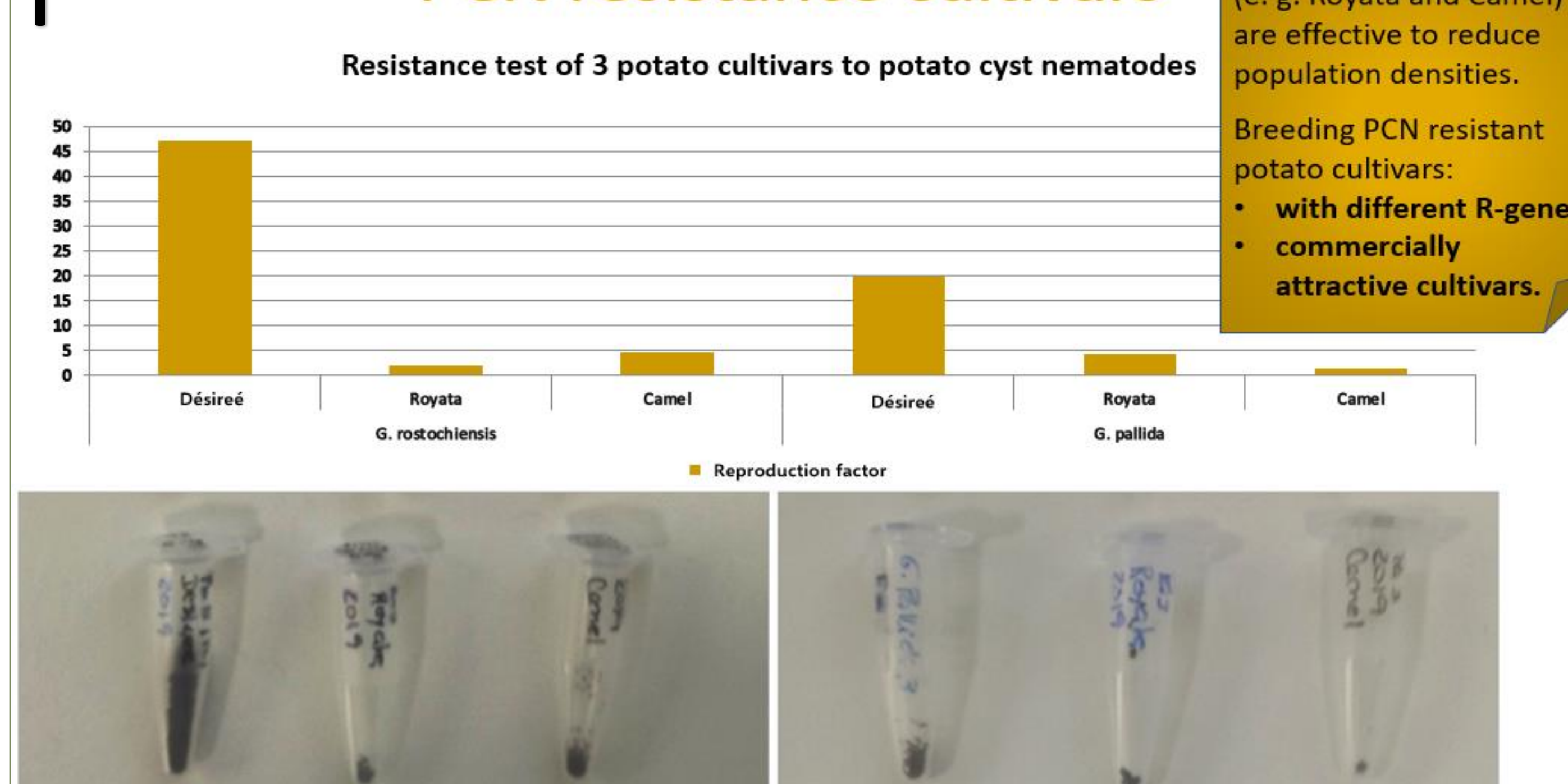
H0: GrResistant = GrSusceptible;
H1: GrResistant ≠ GrSusceptible;
p-value=0.2048, α=0.05

H0: GrResistant ≤ GrSusceptible;
H1: GrResistant > GrSusceptible;
p-value=0.996, α=0.05

G. rostochiensis resistant potato cultivars

- has led to a decrease of *G. rostochiensis*
- has no influence on *G. pallida*.

PCN resistance cultivars



PCN resistance cultivars (e.g. Royata and Camel) are effective to reduce population densities. Breeding PCN resistant potato cultivars: • with different R-genes, • commercially attractive cultivars.

Potato crop (*Solanum tuberosum*) has great social and economic importance in Portugal (A) and potato cyst nematodes (PCN) *Globodera rostochiensis* and *G. pallida* (B) pose one of the greatest threats to potato crops worldwide and are subject to strict quarantine regulations in many countries. To establish the status of PCN in the country, a field survey was conducted in 2010. PCN presence was confirmed in 185 samples through morphological and molecular analyses in a total of 852 soil samples examined (from 2013 to 2020). PCN cysts were detected in all potato growing regions, with a greater incidence of *G. pallida* (C). The patterns of infestation differ among regions, increasing from south to north, where PCN were first detected (C). The increased predominance of *G. pallida* may be a consequence of the phytosanitary measures that have been taken to prevent further spread of PCN in recent years, such as fallow, non-host crops rotation or growing of resistant potato cultivars (D). The use of potato cultivars resistant to *G. rostochiensis* led to a decrease of this species but had no influence on *G. pallida* detections, which continues its reproduction freely since there are no effective resistant cultivars for this species (E). It is urgent to follow a new approach for the management of PCN, mainly *G. pallida*. Breeding new PCN-resistant potato cultivars, should be a priority, once resistant cultivars are effective to reduce PCN population densities (F).