

# The current status of the Cyprus population of *Phytophthora infestans*

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# Cyprus: the southernmost European country



Member states of the European Union  
Candidate countries

# Potato crop production in Cyprus



**Area:** 9,521 km<sup>2</sup>

**Highest point:** Mount Olympus (1,952 m)

**Population:** 803,147 (as of 2010)

# Climate of Cyprus

- Hot and dry summers (mid May - mid September)
- **Mean summer temperature: 30 °C**
- Mild winters (mid November - mid March); 60% of annual rainfall
- **Mean winter temperature: 10 °C**
- Mean annual rainfall (1991-2001): 453 mm (w/ *decreasing trend*)



# Cyprus potatoes



- Cyprus potatoes are renowned for their great flavour and firm texture.
- Cyprus potatoes are easily distinguishable by the reddish colour of their skins, derived from the fertile red soil they are grown mainly in the Kokinochoria region (red-soil villages), at the Eastern region of the island.



# Potato crop production

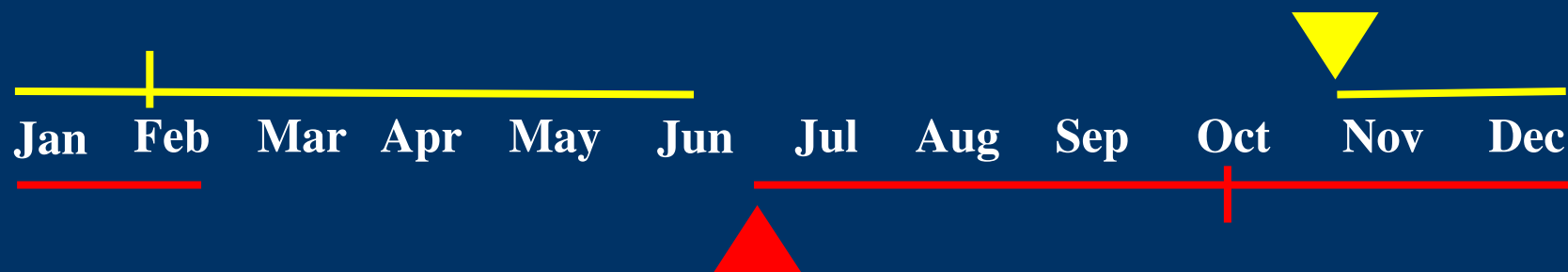


- **Approximately 50% of the total exports exchange of Cyprus regarding agricultural products is due to potato exports, mainly to other European countries (Data 2005).**
- **> 60% of the annual potato production is exported; estimated exports at €47 million (Data 2005).**



# Potato cropping seasons in Cyprus

- **Spring crop** (area: 10,000 acres; 70,000 – 80,000 tons)
  - Planting: November until early February
  - Harvesting: March until mid June
- **Fall-Winter crop** (area: 3,000 – 3,700 acres; 25,000 tons)
  - Planting: June/July until mid October
  - Harvesting: November until end of February



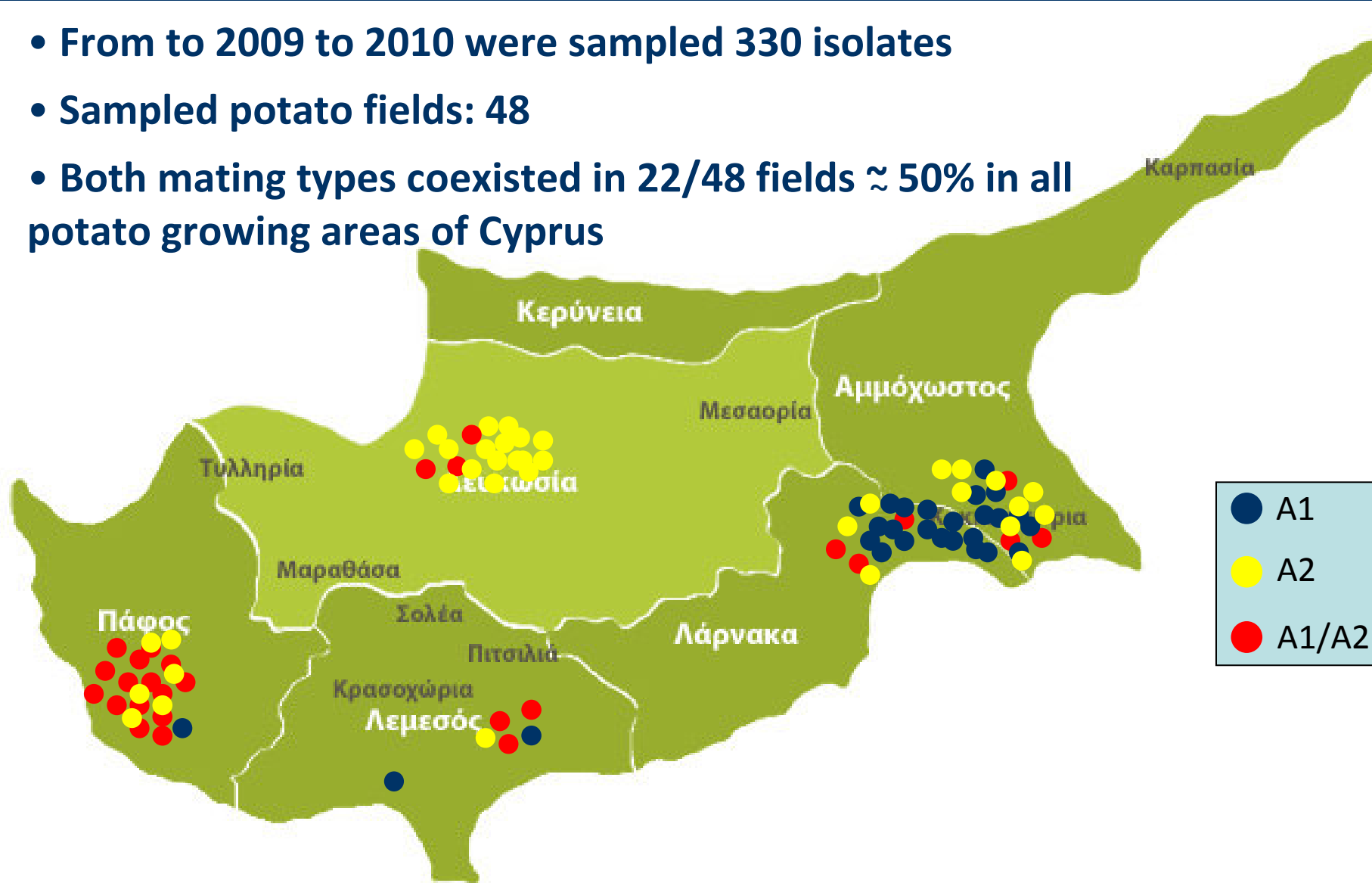
# Potato late blight in Cyprus



- Despite the dry climate of Cyprus, potato late blight can be a serious problem.
- The winter crop is basically affected by the disease (more severe during rainy periods).
- Disease management is based on routine fungicide applications.

# Mating type

- From 2009 to 2010 were sampled 330 isolates
- Sampled potato fields: 48
- Both mating types coexisted in 22/48 fields  $\approx$  50% in all potato growing areas of Cyprus

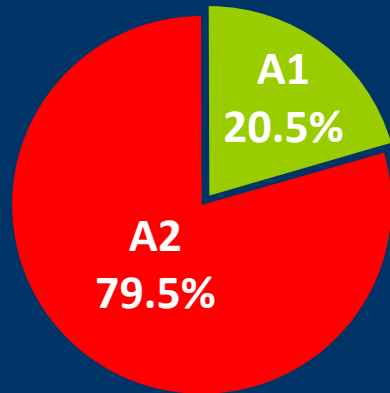


Nevertheless, oospores have never been found in field samples

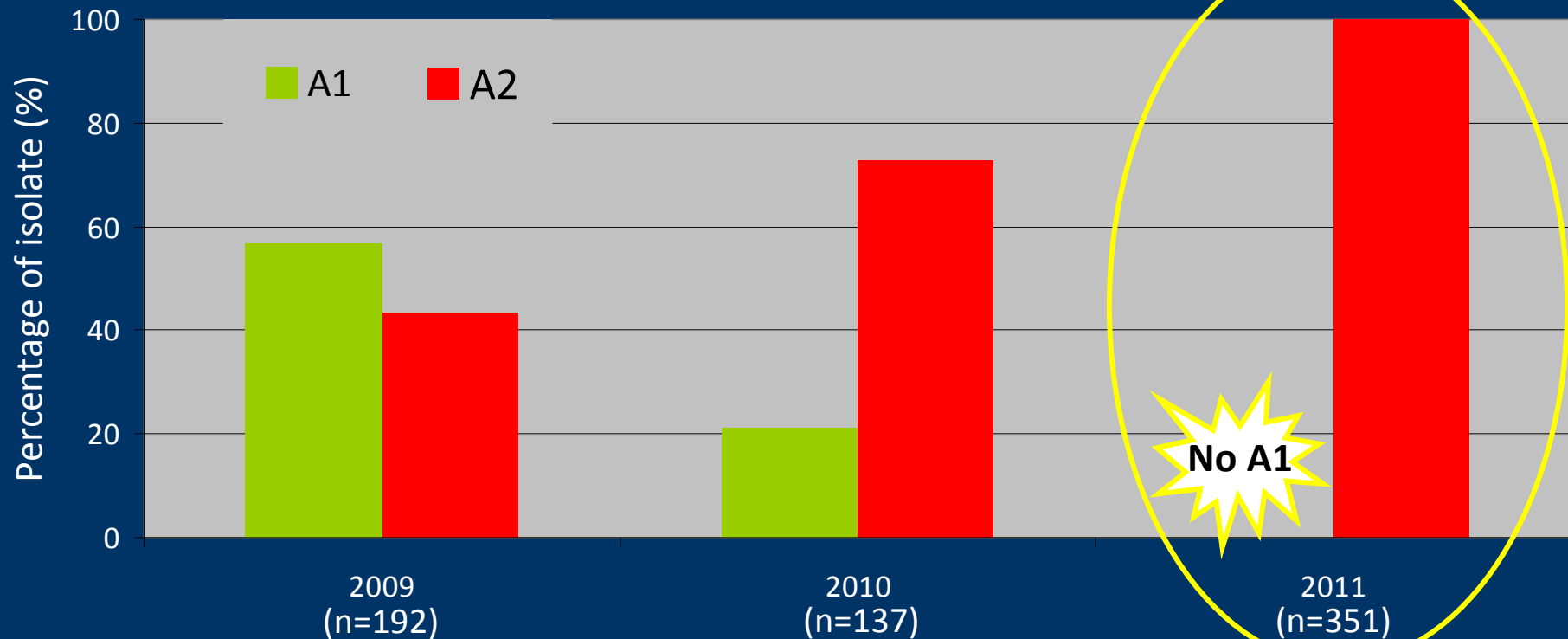


# Mating type

Cyprus 2009-2011 (n=680)

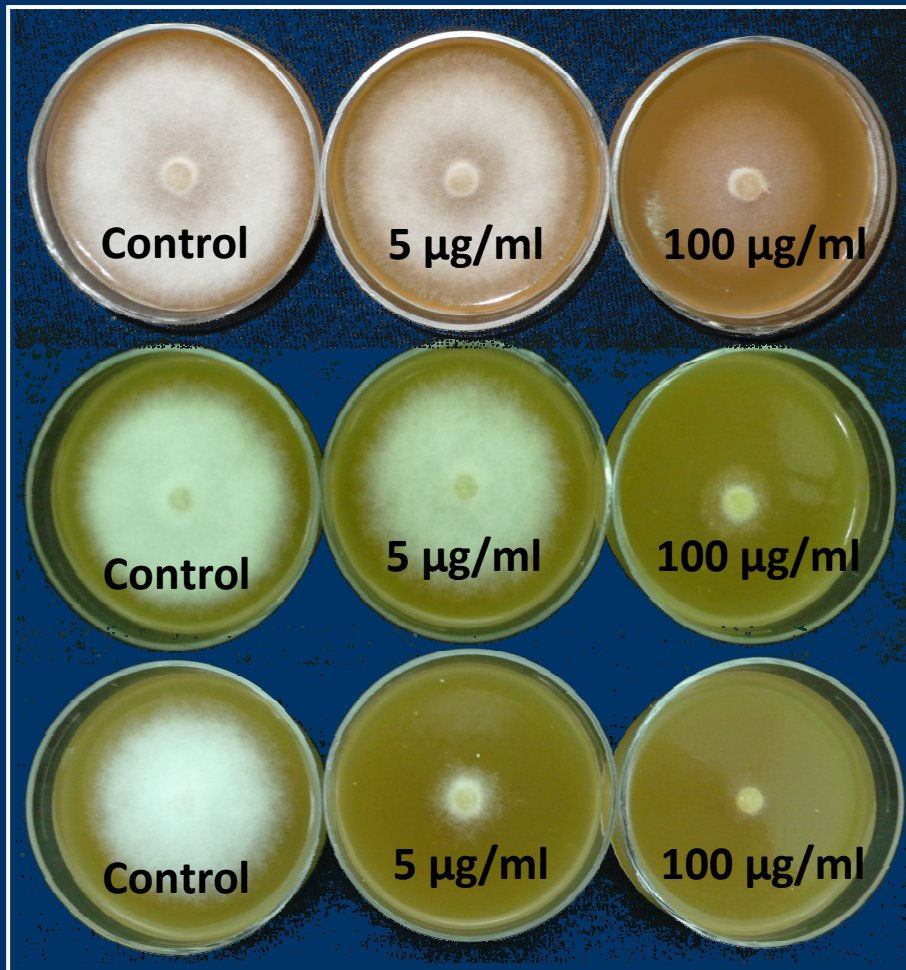


- 2009 and 2010 sampling from all potato growing areas in Cyprus (n=330).
- 2011 sampling took place only in the Pafos municipality (n=350).
- A2 mating type is high and increasing.



# Response to metalaxyl-M

285 isolates were tested for their sensitivities to metalaxyl-M



**Resistant**

100 µg/ml  $\geq$  40% control

**Intermediate Resistant**

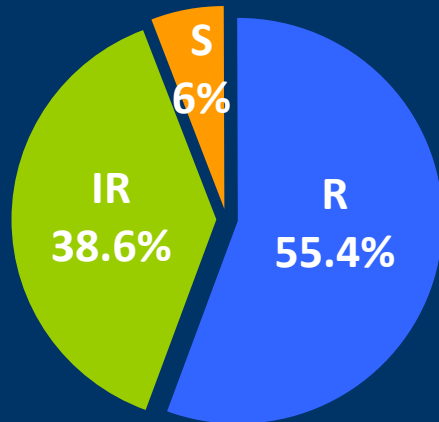
5 µg/ml  $\geq$  40% Μάρτυρας  
100 µg/ml  $<$  40% Μάρτυρας

**Sensitive**

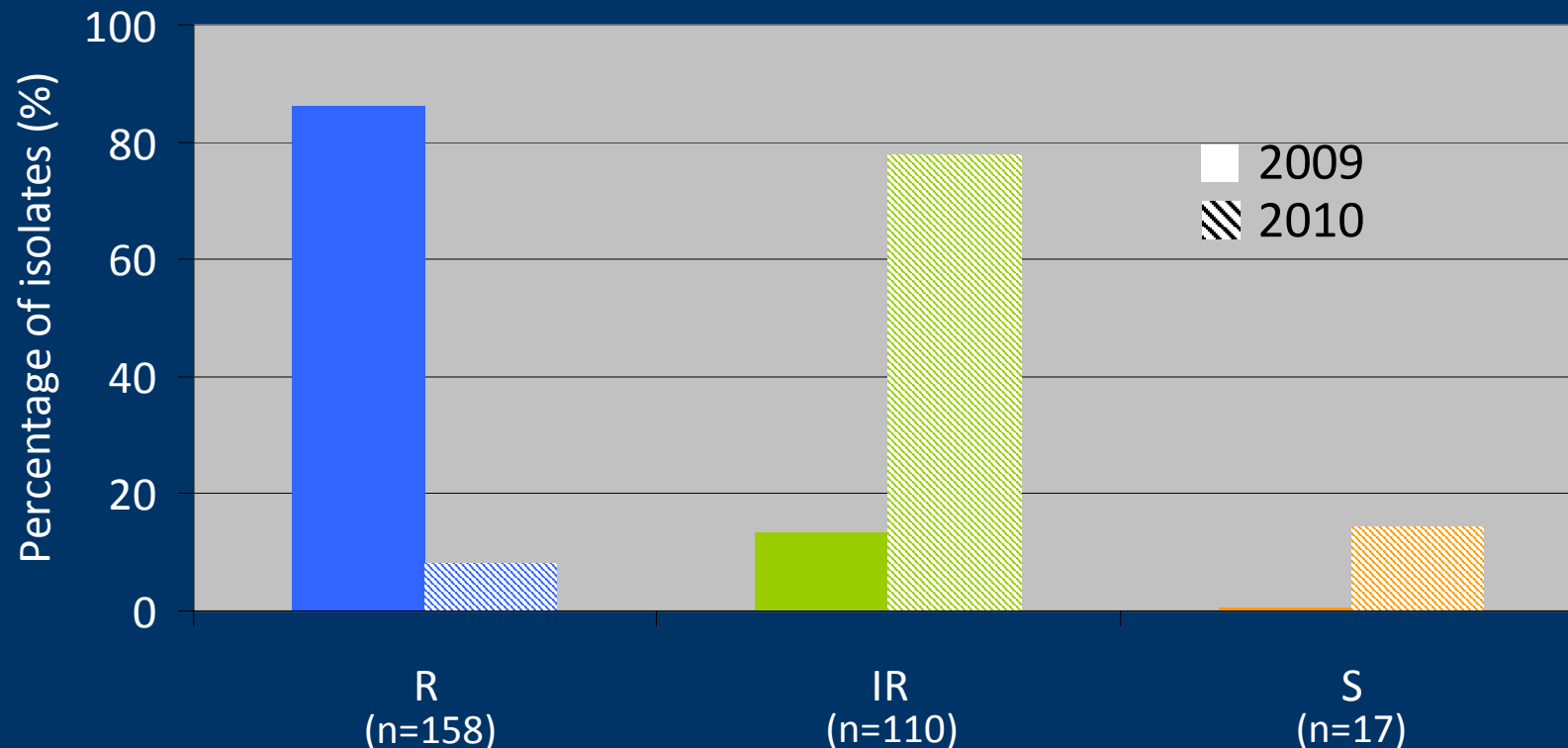
5 µg/ml  $<$  40% Μάρτυρας

# Response to metalaxyl-M

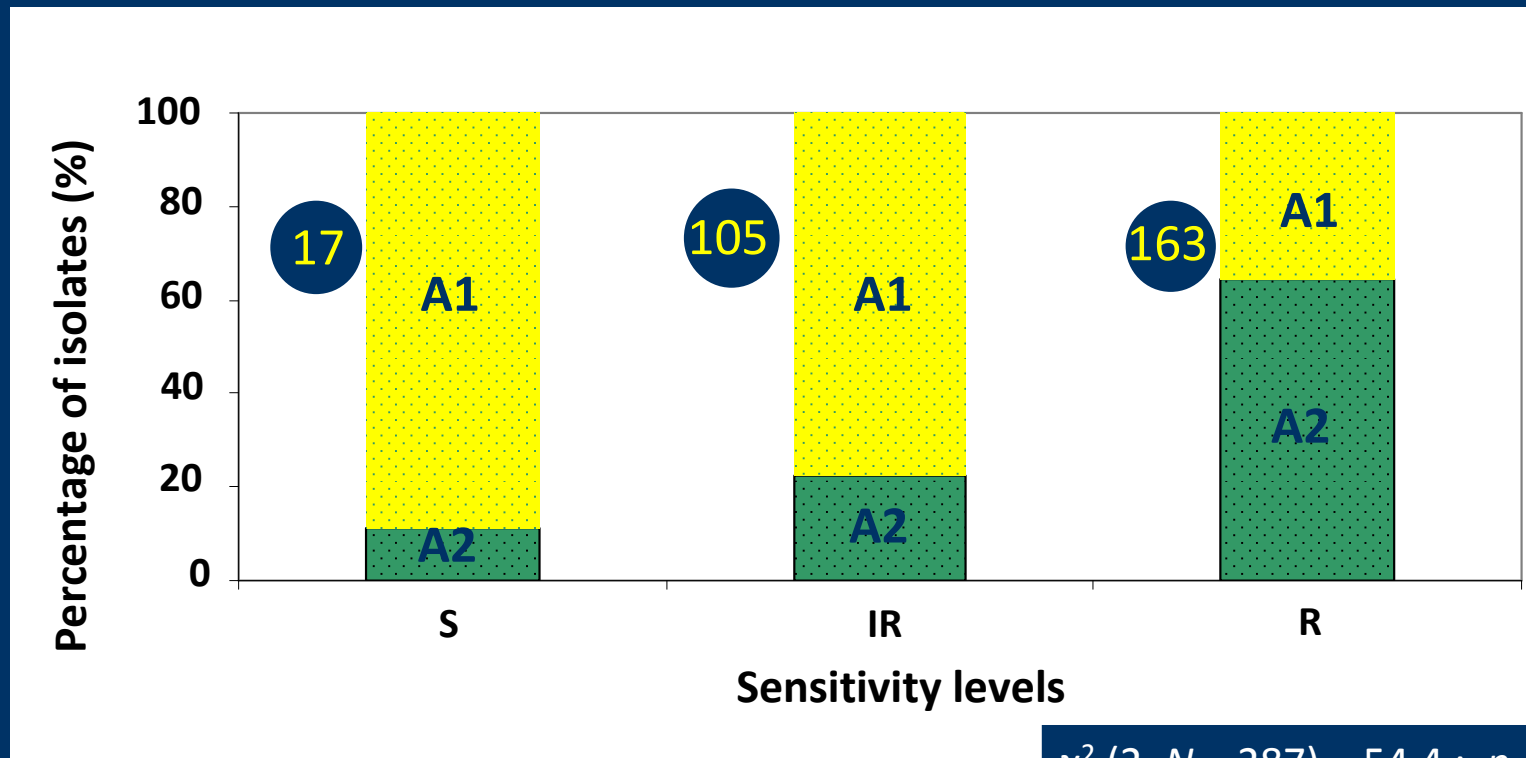
Cyprus 2009-2010 (n=285)



- The proportion of metalaxyl-R isolates fluctuates (*probably due to differences in sampling periods*).
- The percentage of isolates with reduced sensitivity to metalaxyl scores >90% within the tested population.
- **CONCLUDING:** Serious compromise of metalaxyl effectiveness.



# Relationship between sensitivities to metalaxyl-M and mating type

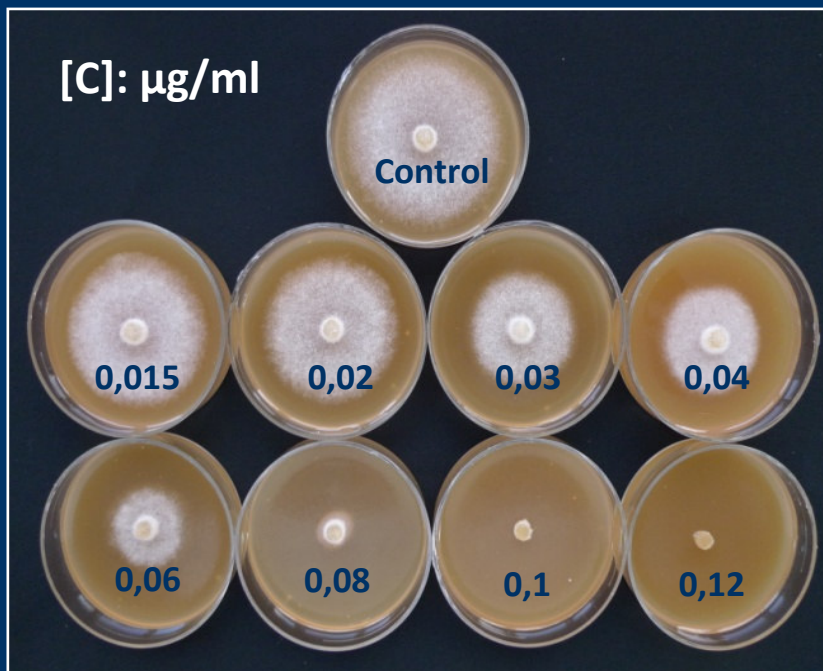


$$\chi^2 (2, N = 287) = 54,4 ; p = <0,0001$$

- A2 > A1 at the metalaxyl-M resistant isolates of *P. infestans*.
- A1 > A2 at the metalaxyl-M sensitive and intermediate resistant isolates of *P. infestans*.

# Sensitivity ranges to commonly used fungicides against *P. infestans*

- *In vitro* and *in vivo* sensitivities ( $EC_{50}$  values) of 70 isolates to **cymoxanil**, **mandipropamid** and **propamocarb-HCl** were estimated.
- Cymoxanil and propamocarb-HCl have been widely used in Cyprus for a period of years, while mandipropamid was recently introduced (2010; *baseline*)





# Fungicide sensitivities

Active ingredient	Reference	Range EC <sub>50</sub> values (µg/ml)	Mean EC <sub>50</sub> values (µg/ml)	Method
cymoxanil	Cyprus	0.05 - 0.84	0.23	<i>in vitro</i>
	Zhu et al. 2008	0.05 - 0.46	0.17	<i>in vitro</i>
mandipropamid	Cyprus	0.001 - 0.040	0.0078	<i>in vivo</i>
	Cohen et al., 2007	0.007 - 1.17	-	<i>in vivo</i>
propamocarb-HCl	Cyprus	74 - 1340	579	<i>in vitro</i>
	Möller et al., 2009	100 - 1000	-	<i>in vitro</i>

# Where do we stand?

Formulated product/ active ingredient (% a.i.)	Suggested application dose (Label)	Suggested applied concentration (Label; µg/ml)	Estimated mean EC <sub>50</sub> value (µg/ml)
Antiperon WP/ cymoxanil (5,92%)	230g/100L	13,6 ✓	0,23
Revus 25 SC/ mandipropamid (25%)	50g/50L	250 ✓	0,014
Ridomil Gold Plus 42,5 WP/ metalaxyl-M (2,5%)	300g/100L	75 ?	<i>Discrimination dose</i> 100
Previcur N/ propamocarb-HCL (72,2%)	120g /100L	870 ✓	579

*In vitro* and *in vivo* sensitivity tests (EC<sub>50</sub> values) with Cyprus populations of *P. infestans* support:

- Effective action of cymoxanil, mandipropamid and propamocarb-HCl
- Compromised effectiveness of metalaxyl-M

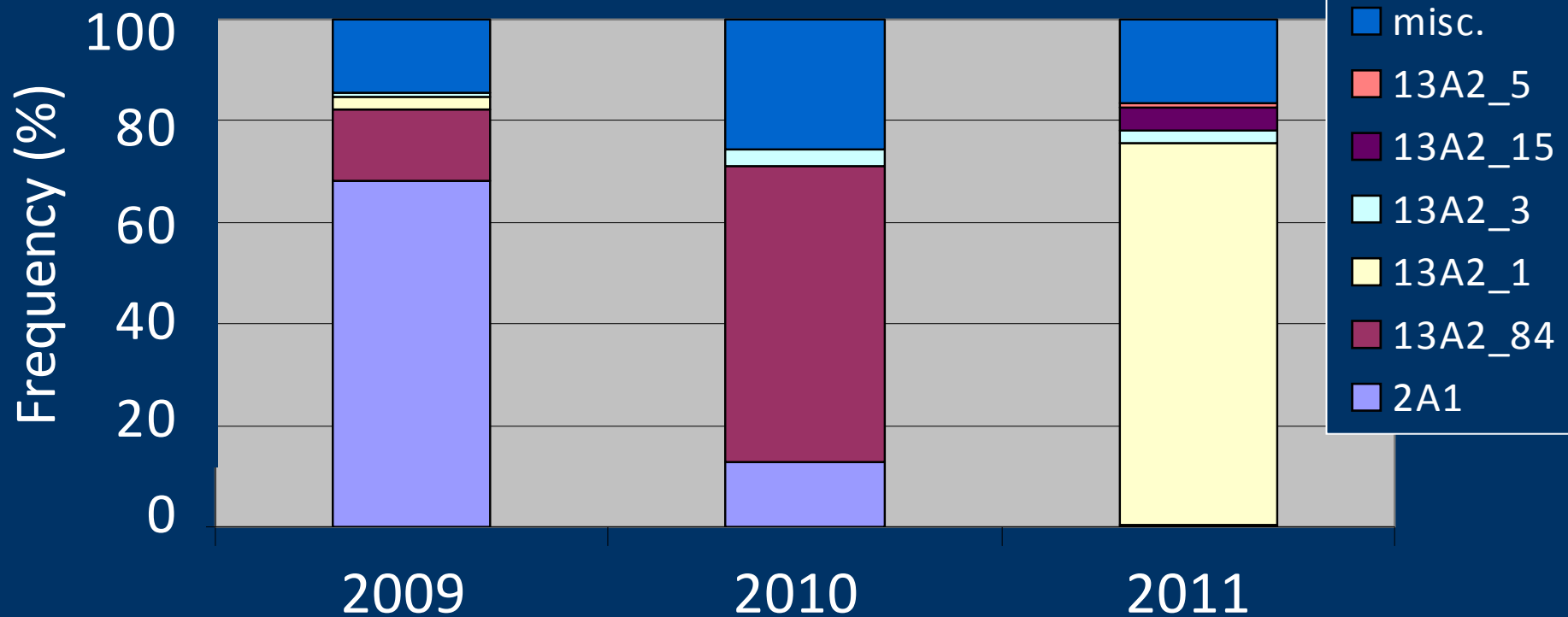
# Genotyping of *P. infestans* with SSR markers

	Tested in Cyprus (CUT) <i>(in collaboration with D. Cooke)</i>
Number of isolates	530
Regions / locations / fields	5 / 17 / 49
Isolates/year	2009: 120 <i>(all over Cyprus)</i>
	2010: 55 <i>(all over Cyprus)</i>
	2011: 355 <i>(single field in Pafos)</i>

# Genotyping of *P. infestans* with SSR markers

	Tested in Cyprus (CUT) <i>(in collaboration with D. Cooke)</i>
Number of markers	12
Polymorphic markers	12
Mean number of alleles/marker (range)	4,25 (2-10)
Number of different genotypes	43
Most polymorphic markers	D13 > G11 > SSR3, SSR4
Least polymorphic markers	Pi04, Pi70, SSR2, SSR11

# Genotyping of *P. infestans* with SSR markers



- 2009: 2\_A1 (old clonal lineage); > 65%
- 2010: 13A2\_84 (a 13\_A2 variant); >55%
- 2011: 13A2\_1; >75%

**Other genotypes like 23\_A1 and 13\_A2 variant were found as well.**





# Variation of 13\_A2 – SSR markers

- **Sampling 2009 – 2010**

- 175 isolates from all potato cultivating regions of Cyprus
- Six 13\_A2 variants were detected
- Variant 13\_A2\_84 was the most popular

- **Sampling 2011**

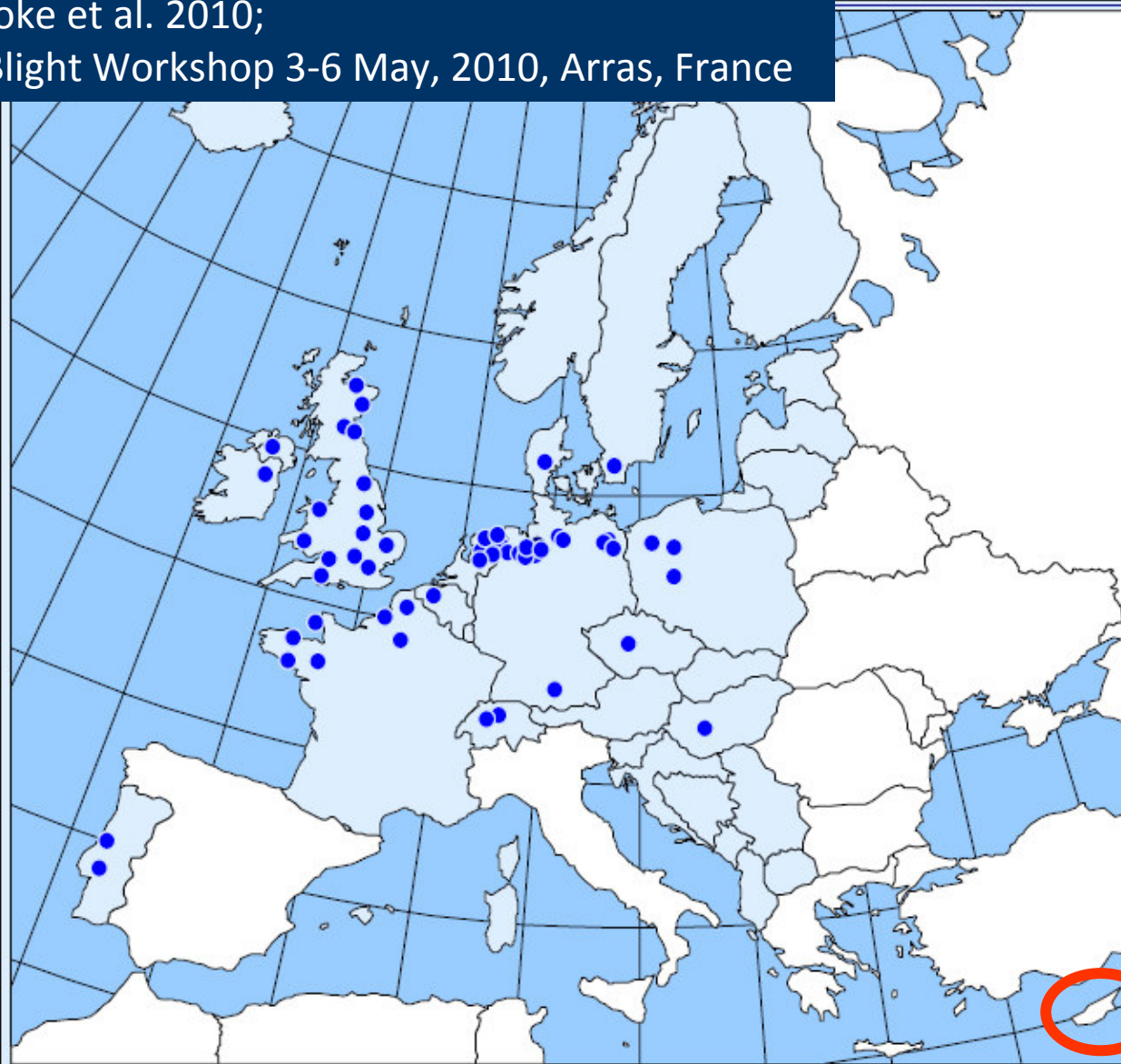
- 355 isolates from a single potato field
- Twenty five 13\_A2 variants were detected
- Variant 13\_A2\_1 was by far the most predominant one



# EU-scale distribution of genotype 13\_A2



D. Cooke et al. 2010;  
EuroBlight Workshop 3-6 May, 2010, Arras, France



• New entry: CY



# Conclusions

- Both mating types are present in Cyprus.
- Metalaxyl-M effectiveness seems to be compromised within the Cyprus populations of *P. infestans*.
- Baseline sensitivities to mandipropamid have been estimated.
- No-resistant isolates of *P. infestans* to cymoxanil, mandipropamid and propamocarb-HCl were detected.
- 43 genotypes of *P. infestans* were found in the local population with the aid of SSR's
- Interestingly many 13\_A2 variants were detected in the 3-year period of the study.

# Acknowledgements

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*Thank you all for your attention!*



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