

Ongoing changes in the Irish potato blight population

Louise Cooke¹

*Steven Kildea², Jeanne Mehenni-Ciz², Lisa Quinn¹, George Little¹,
Fiona Hutton², Frances Perez³, Ken Deahl³ & Denis Griffin²*

¹Agri-Food & Biosciences Institute, Belfast

²Teagasc Oak Park Research Centre, Carlow

³USDA, ARS, Vegetable Laboratory, USA



An Integrated Biosciences Platform for the Future Control of Potato Late Blight on the Island of Ireland 2007 – 2012

*Funded by the Department of Agriculture, Fisheries and Food
under the National Development Plan 2007-2013 through the
Research Stimulus Fund*

*Teagasc, Oak Park
AFBI, Belfast
University of Wales, Bangor
Co-ordinated by Denis Griffin*

Phytophthora infestans in Ireland 1980s to 2007

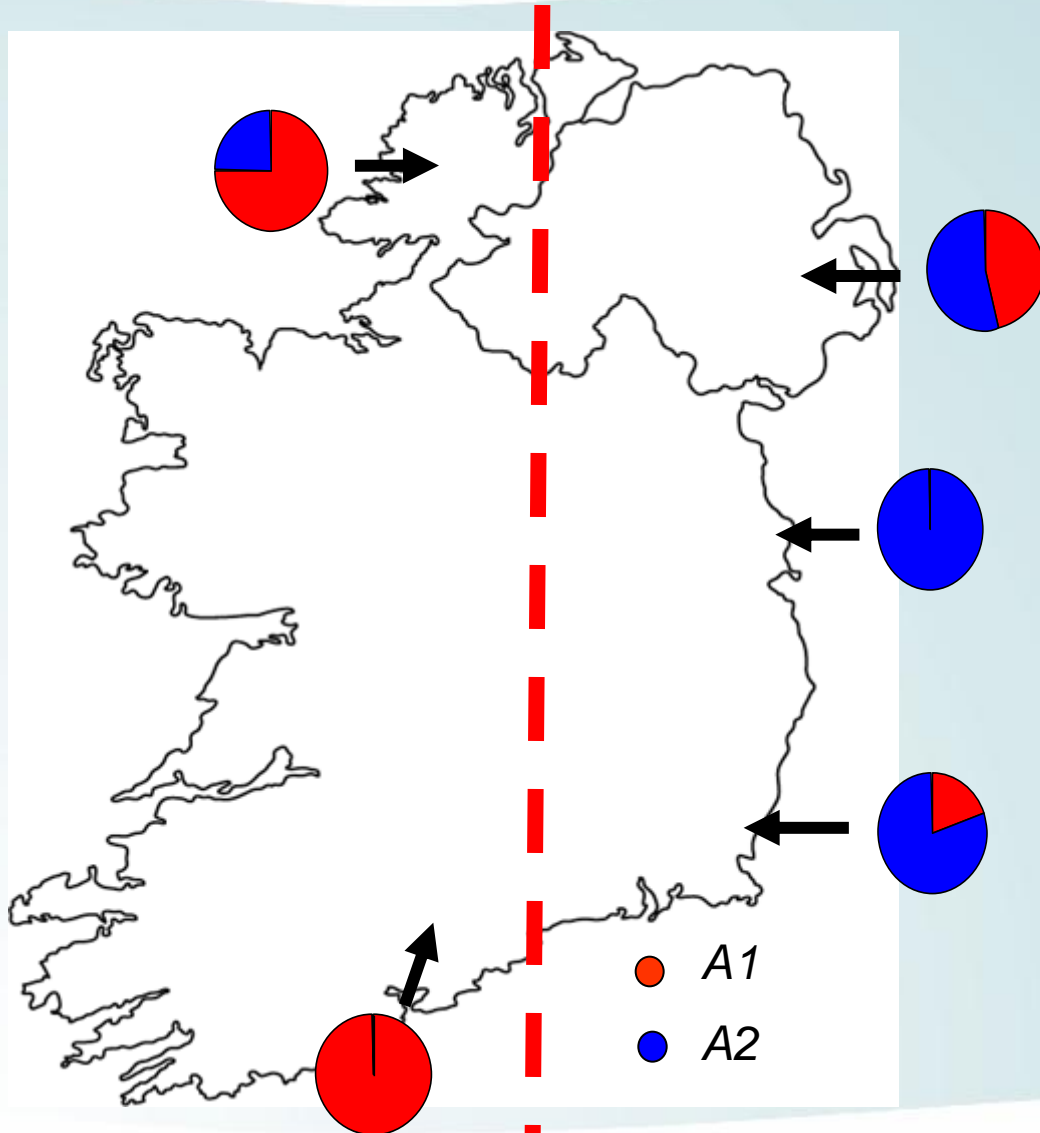
- *Relatively stable population dominated by two A1 clonal lineages*
 - *IE-1/NI-1 (8_A1) mtDNA IIa, mainly metalaxyl S*
 - *IE-2/NI-2 (5_A1) mtDNA Ia, metalaxyl R*
- *A2 mating type present but at a very low frequency (not found 1996-2005)*
- *Phenylamide resistance present but manageable*
- *Disease control generally not too problematic*
- *But aware of changes in GB population*

EuroBlight 2010 – concluding comments

- *Irish blight population has undergone a dramatic change in last two years (2008-2009)*
- *Changes due to emergence of the A2 strain Blue 13*
- *Emergence of new A1 strain ‘Pink 6’ in Donegal will need to be closely watched*
- *Changes are affecting how we control disease*



2009 Collection



- *Further increase in A2*
- *East-West Divide*
- *A2 detected from start of season*
- *Both mating types detected in same fields*

| | | |
|-----|----------|--------------|
| Rol | 48 sites | 266 isolates |
| NI | 45 sites | 159 isolates |

EuroBlight 2010

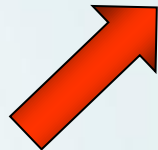
- *Irish blight population underwent a dramatic change in 2008-2009*
- ***What has happened since then?***



Sample Collection

Department Inspectors

Teagasc Advisors



Ourselves

Farmers

General Public

Sample Collection

DARD Inspectors



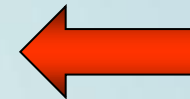
Newforge



AFBI



General Public



Farmers

Phytophthora infestans 2010

- *Very few blight outbreaks in 2010 in either NI or Rol*
- *Dry weather early season probably prevented primary infections from developing and spreading*
- *NI: 10 outbreaks sampled in NI extensive survey, 51 isolates, plus 2 intensively sampled sites*
- *Rol: only 6 outbreaks sampled, 10 isolates obtained*



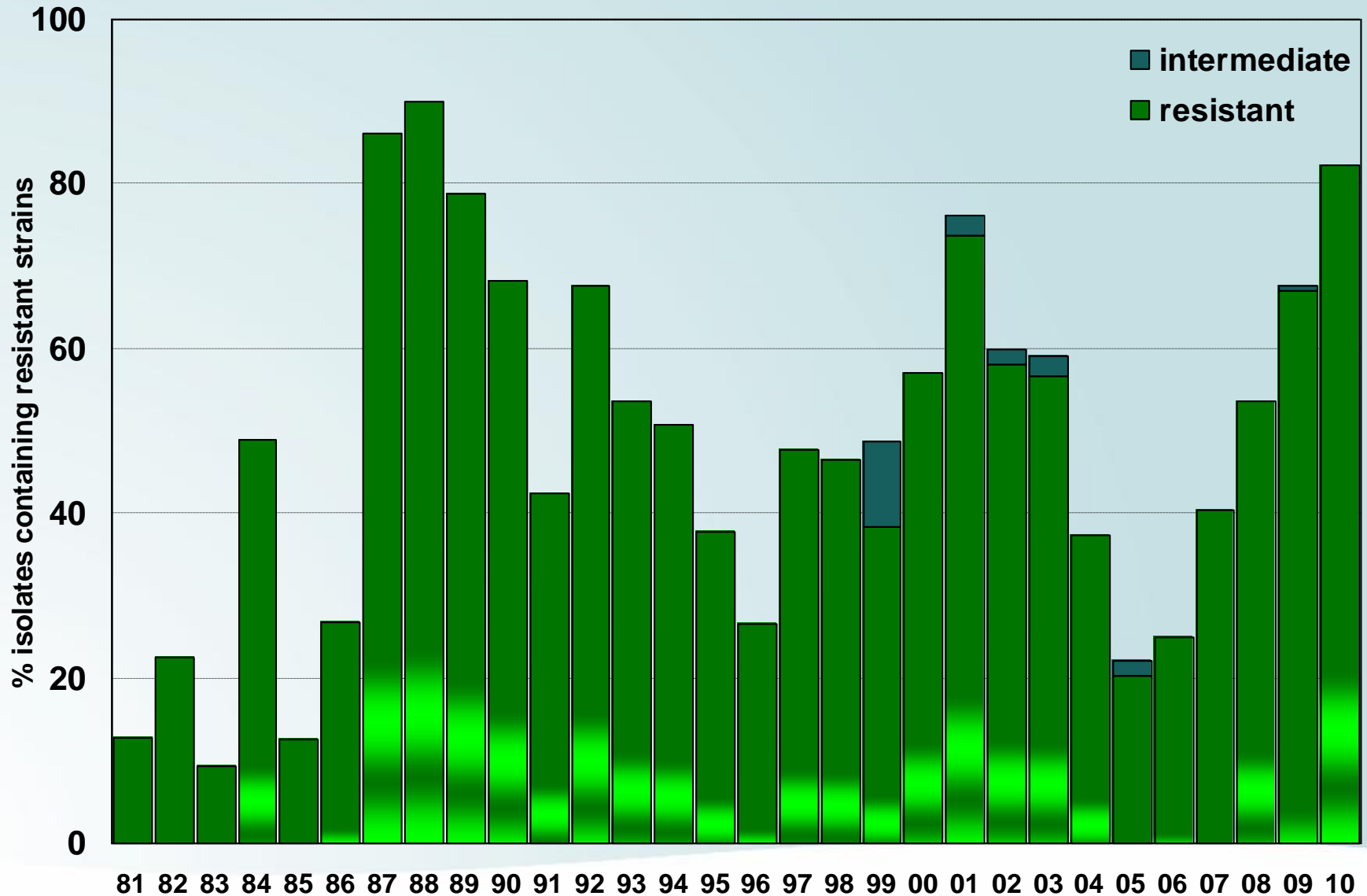
***Phytophthora infestans* 2010**

Northern Ireland

- ***Phenylamide resistance***
- *51 isolates from 10 sites tested (36 from one site)*
- *The incidence of phenylamide-resistant strains continued to increase to 82% in 2010 (60% of sites)*
- *But 36 of the 42 resistant isolates were from AFBI Crossnacreevy (unsprayed differentials, selected cultivars)*



The proportion of Northern Ireland Phytophthora infestans isolates containing phenylamide-resistant strains, 1981-2010



Phytophthora infestans 2010

Northern Ireland

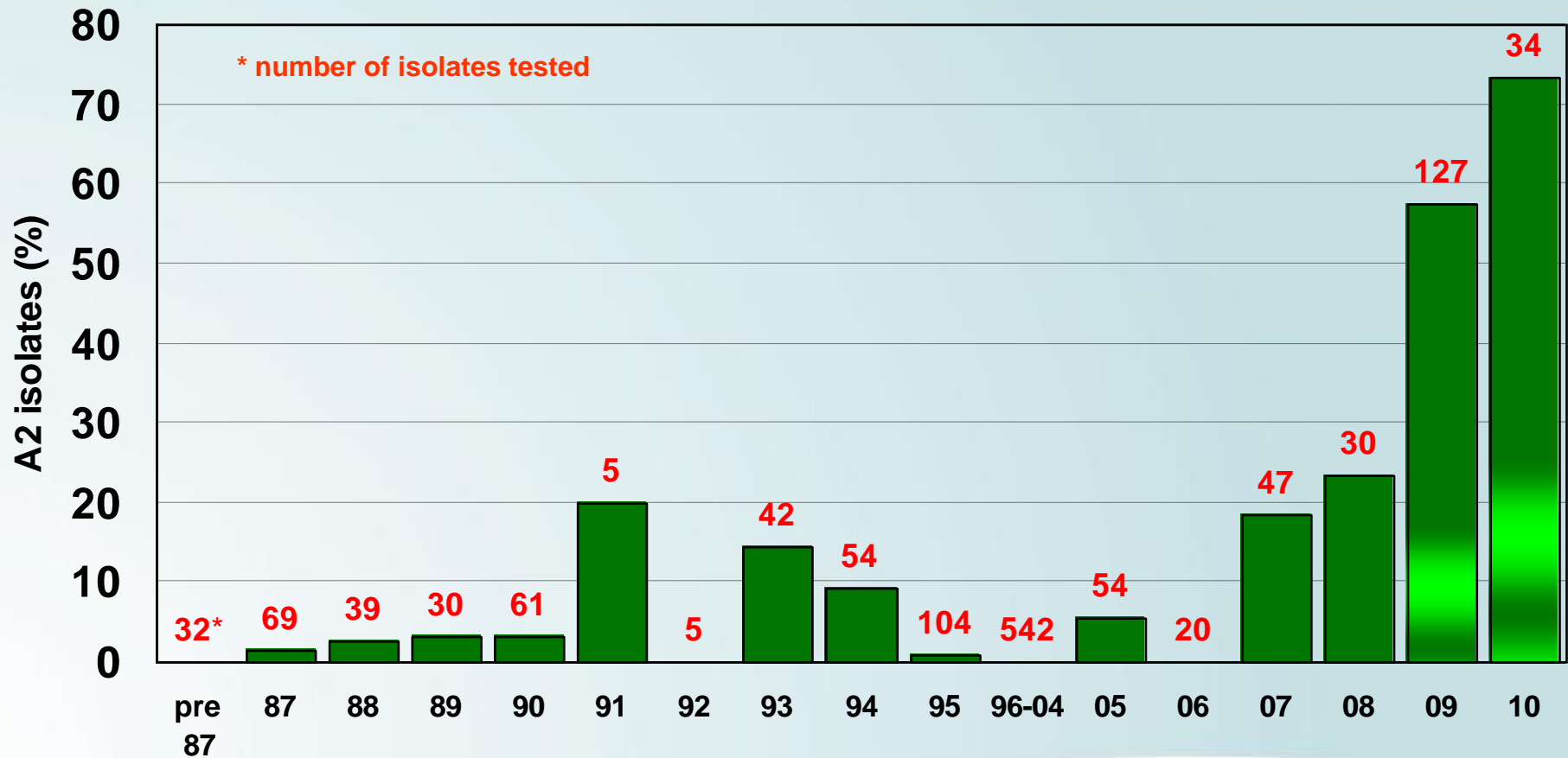
- **Mating type**
 - 34 isolates from 10 sites tested for mating type
 - 4 sites A1 (Antrim, L'derry), 5 sites A2 (Down), 1 site A1+A2 (Antrim)
 - A2 more frequent in south and east (as in 2009)
 - 9 isolates A1, 23 A2 (74%), but 19 A2 isolates from AFBI Crossnacreevy



Phytophthora infestans 2010

Northern Ireland

- *Mating type*



Phytophthora infestans 2010

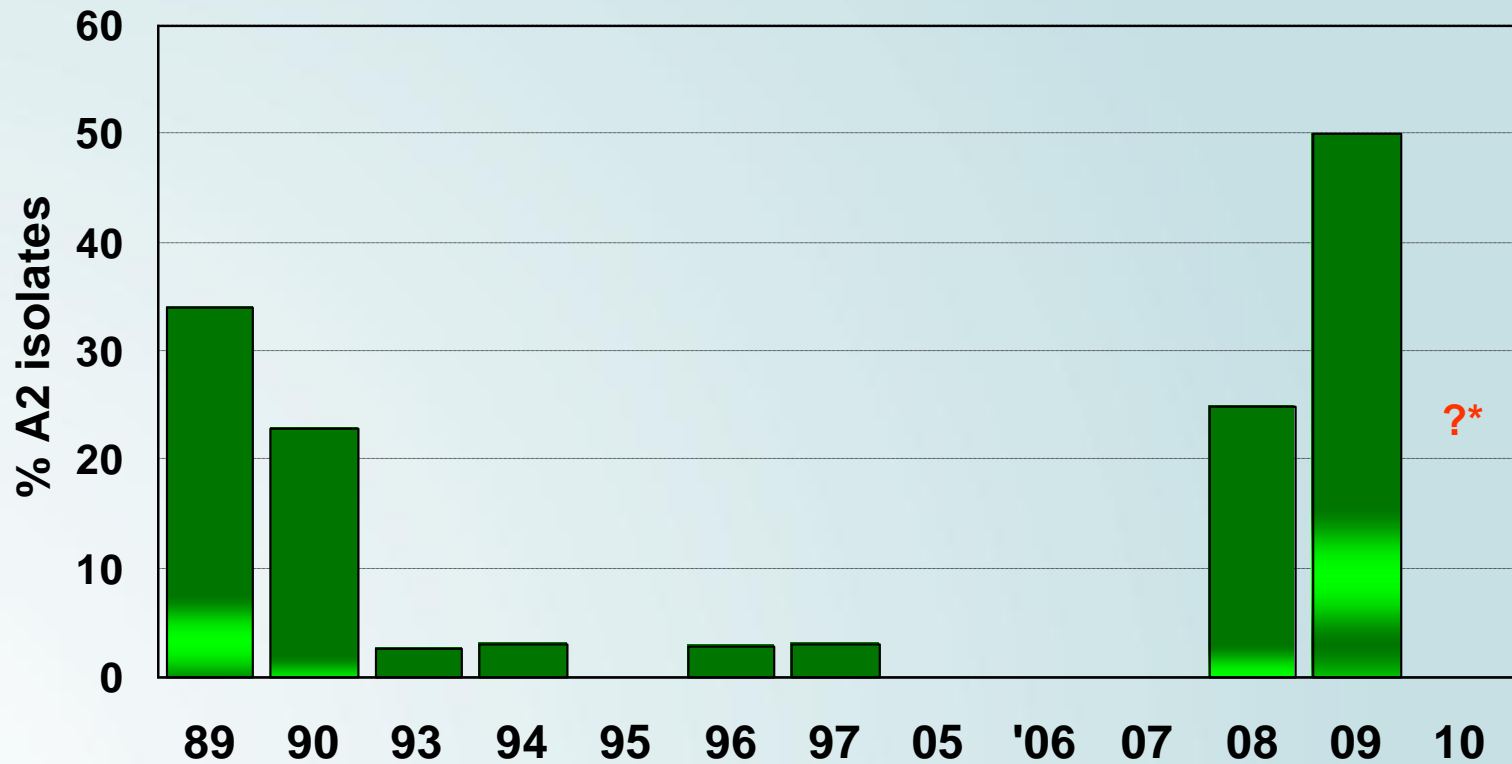
Northern Ireland

- ***Phenylamide resistance and mating type***
- *36 of the 42 resistant isolates were from AFBI Crossnacreevy and all these were A2*
- *Of the 24 resistant isolates which were mating typed, all but one was an A2*
- *All A2 isolates were phenylamide-resistant*

Phytophthora infestans 2010

Republic of Ireland

- *Mating type*



* too few isolates in 2010 to give a figure for % A2

Phytophthora infestans 2011

- *Weather more favourable to blight than in 2010*
- *Phenotypic and genotypic characterisation of isolates ongoing*
- *NI: 27 sites sampled (including differentials at AFBI Crossnacreevy), 86 isolates*
- *Rol: 12 sites sampled, 89 isolates*



Phytophthora infestans 2011

Northern Ireland

- *Most outbreaks were in the north-west*
- *26 sites sampled*
 - *L'derry 12*
 - *Tyrone 1*
 - *Antrim 5*
 - *Down 8*



***Phytophthora infestans* 2011**

Northern Ireland

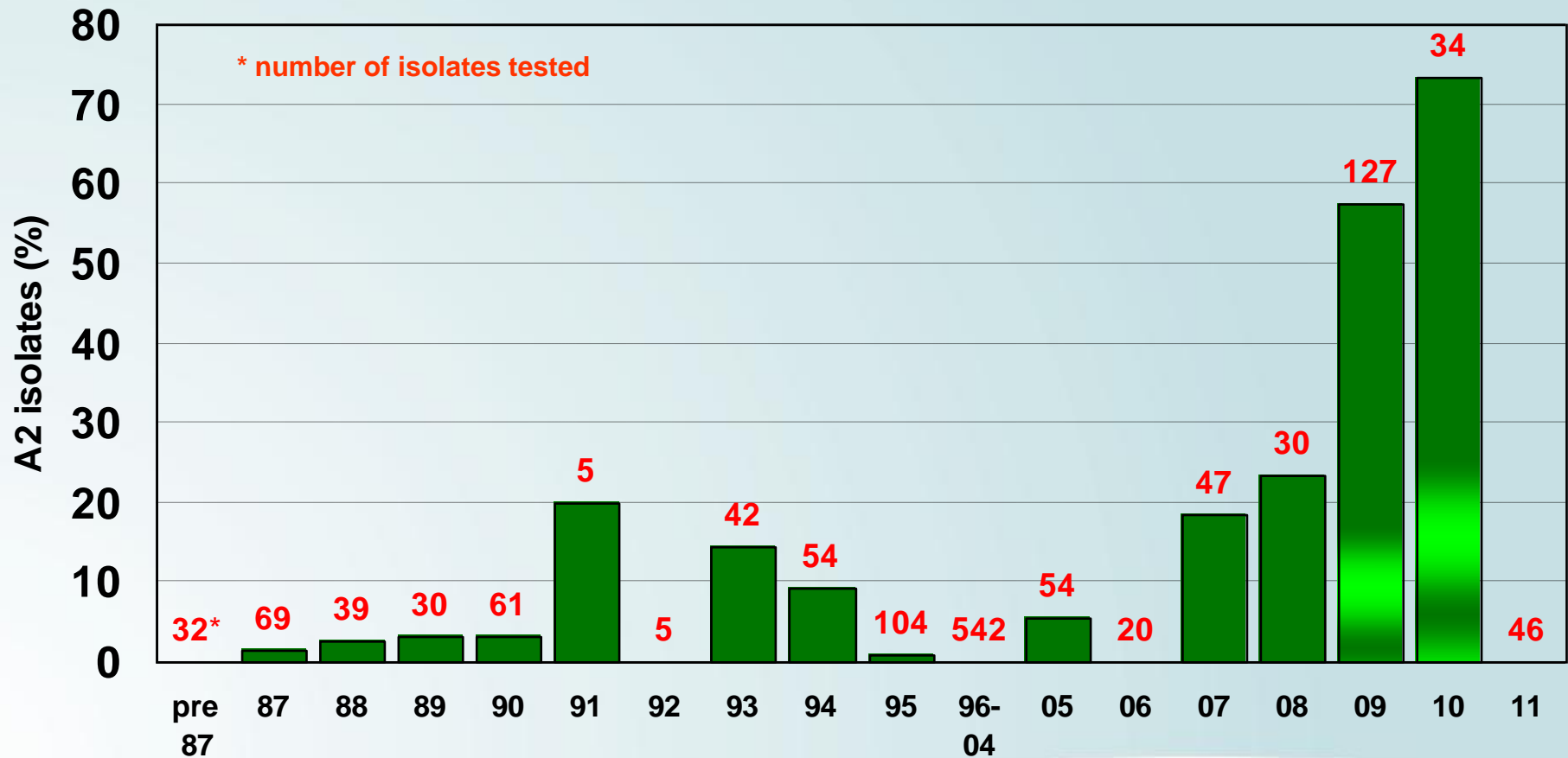
- ***Mating type***
- *Testing ongoing*
- *46 isolates have given results to date – **all A1!***
- *17 sites with mating type results*
 - *L'derry 9 (20 isolates)*
 - *Antrim 5 (17 isolates)*
 - *Down 3 (9 isolates)*
- ***What's going on?***



Phytophthora infestans 2011

Northern Ireland

- Mating type**



Phytophthora infestans 2011

Republic of Ireland

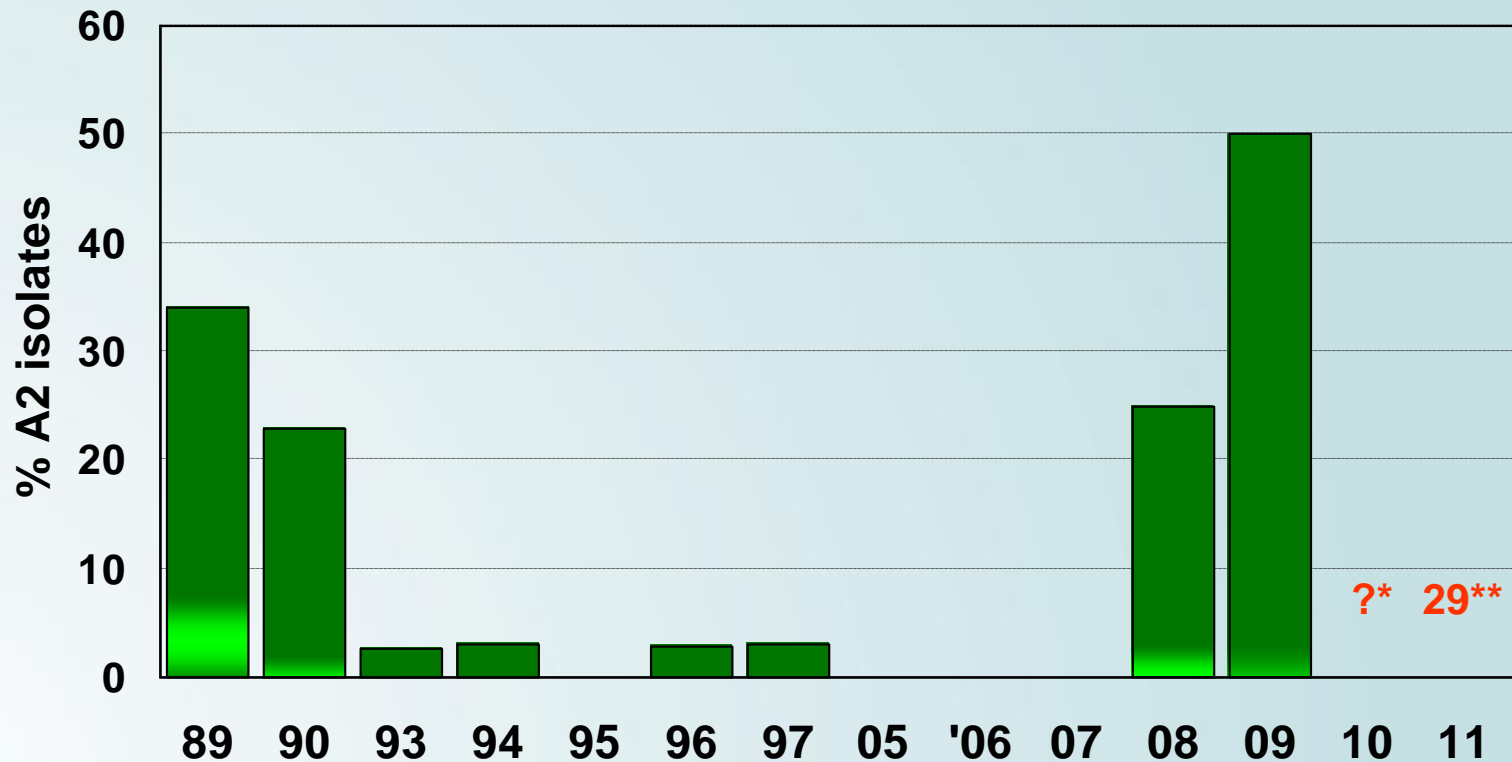
- *Mating type*
- *Testing ongoing*
- *29 isolates have given results to date – all A1!*
- *8 sites with mating type results*
 - *Donegal 6 (21 isolates)*
 - *Carlow 1 (5 isolates)*
 - *Kerry 1 (3 isolates)*
- *What's going on?*



Phytophthora infestans 2011

Republic of Ireland

- *Mating type*



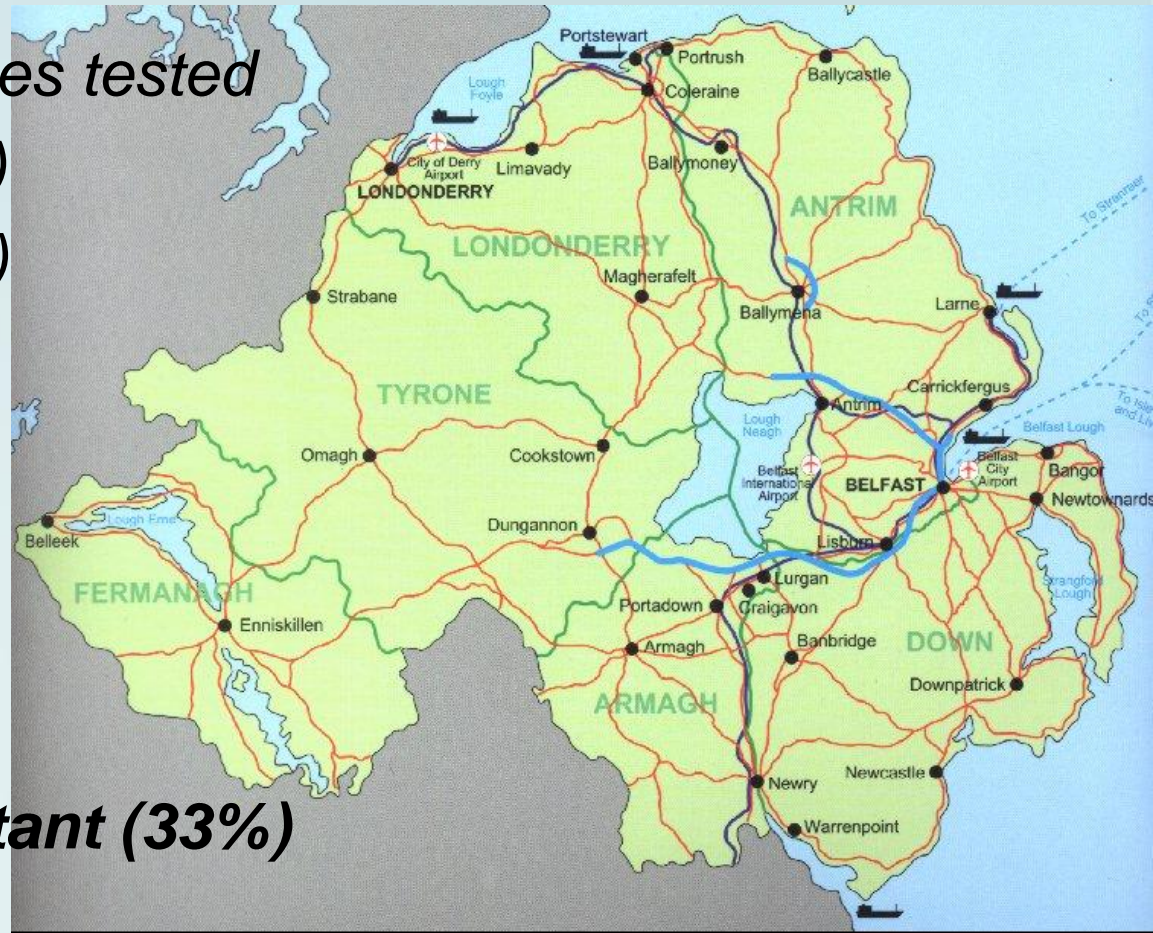
* too few isolates tested in 2010 to give a figure for % A2

** 29 isolates tested to date, all A1

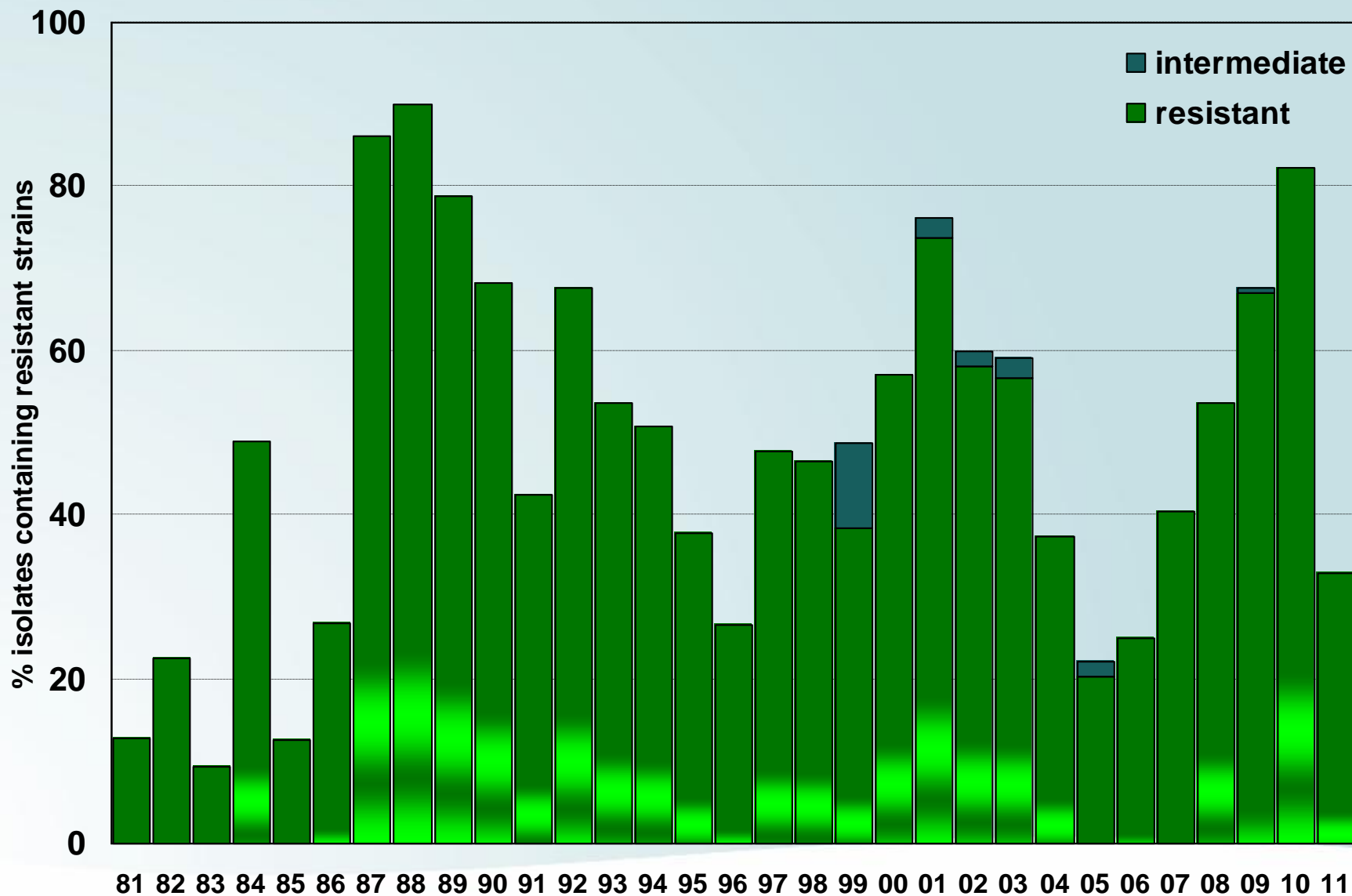
Phytophthora infestans 2011

Northern Ireland

- **Phenylamide resistance**
- **85 isolates from 26 sites tested**
 - **L'derry 30 (17% R)**
 - **Tyrone 4 (100% R)**
 - **Antrim 17 (0% R)**
 - **Down 34 (56% R)**
- **overall only 28 resistant (33%)**
- **Reversal of trend?**



*The proportion of Northern Ireland *Phytophthora infestans* isolates containing phenylamide-resistant strains, 1981-2011*



Phytophthora infestans 2011

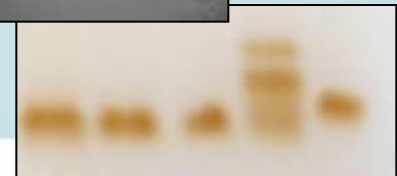
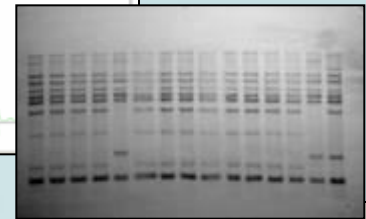
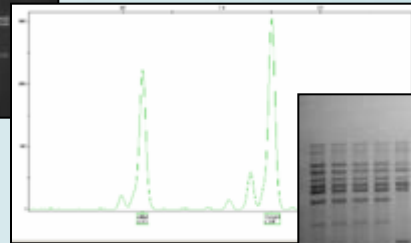
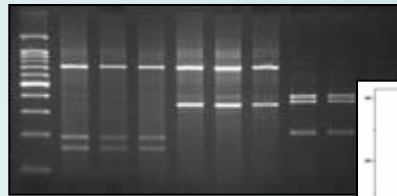
Northern Ireland

- ***Phenylamide resistance and mating type***
- *Of the 28 resistant isolates, only 2 have so far given results for mating type and these were A1*
- *We are waiting with interest to see what mating type the remaining isolates will prove to be!*

Phytophthora infestans genotyping

Genotypic characterisation

- *mtDNA*
- *SSR*
- *RG57* (sub-set)
- *Gpi/Pep allozymes* (sub-set)



Phytophthora infestans genotyping

Northern Ireland

Selected isolates have been analysed to date:

- 2009 - *mtDNA, Gpi/Pep allozymes, SSR, RG57*
- 2010 – *Gpi/Pep allozymes, RG57*
- 2011 – *Gpi/Pep allozymes*
- *Characterisation ongoing*

| Isolate | Mt | Pi02 | Pi02 | Pi02 | D13 | D13 | D13 | Pi33 | Pi33 | Pi33 | Pi04 | Pi04 | Pi04 | Pi4B | Pi4B | Pi4B | Pi16 | Pi16 | Pi16 | G11 | G11 | G11 | Pi56 | Pi56 | Pi63 | Pi63 | Pi70 | Pi70 | Pi89 | Pi89 | Gt |
|--------------|----|------|------|------|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|------|------|------|------|------|------|------|------|-------|
| 09DL7-5E-T2 | A1 | 152 | 160 | 162 | | | | 203 | 203 | | 166 | 170 | | 213 | 217 | | 178 | 178 | | 160 | 160 | | 174 | 176 | 151 | 157 | 192 | 195 | 181 | 197 | 6_A1 |
| 09DL16-1A | A1 | 152 | 160 | 162 | | | | 203 | 203 | | 166 | 170 | | 213 | 217 | | 178 | 178 | | 160 | 160 | | 174 | 176 | 151 | 157 | 192 | 195 | 181 | 197 | 6_A1 |
| 09DL12-2A-T2 | A1 | 152 | 160 | 162 | | | | 203 | 203 | | 166 | 170 | | 213 | 217 | | 178 | 178 | | 160 | 160 | | 174 | 176 | 151 | 157 | 192 | 195 | 181 | 197 | 6_A1 |
| 09DL3-2A | A1 | 162 | 162 | | 136 | 136 | | 203 | 203 | | 166 | 170 | | 205 | 217 | | 176 | 178 | | 156 | 162 | | 176 | 176 | 157 | 157 | 192 | 195 | 179 | 181 | 8_A1 |
| 09DL3-2A | A1 | 162 | 162 | | 118 | 136 | | 203 | 206 | | | | | | | | 176 | 178 | | 166 | 166 | | 176 | 176 | | | | | 179 | 181 | 8_A1 |
| 09WX7-1B | A2 | 160 | 162 | | 136 | 154 | | 203 | 203 | | 166 | 170 | | 205 | 213 | | 176 | 178 | | 154 | 160 | | 174 | 176 | 151 | 157 | 192 | 192 | 179 | 179 | 13_A2 |
| 09WX7-2B | A2 | 160 | 162 | | 136 | 154 | | 203 | 203 | | 166 | 170 | | 205 | 213 | | 178 | 178 | | 154 | 160 | 164 | 174 | 176 | 151 | 157 | 192 | 192 | 179 | 179 | 13_A2 |

Phytophthora infestans genotyping

Northern Ireland

- *Excellent agreement between different methods of characterisation*
- *Extremely limited diversity: only 5 genotypes detected, but 3 are infrequent*
 - *5_A1: NI-2/IE-2, Pep 100/100, mtDNA Ia R, 2nd commonest type in 1990s, not found since 2008*
 - *12_A1: mtDNA Ia R/S, not present in 1990s, found in 2008, 2009*
 - *6_A1: Pink 6, Pep 96/96, mtDNA Ib S, first found in 2009*

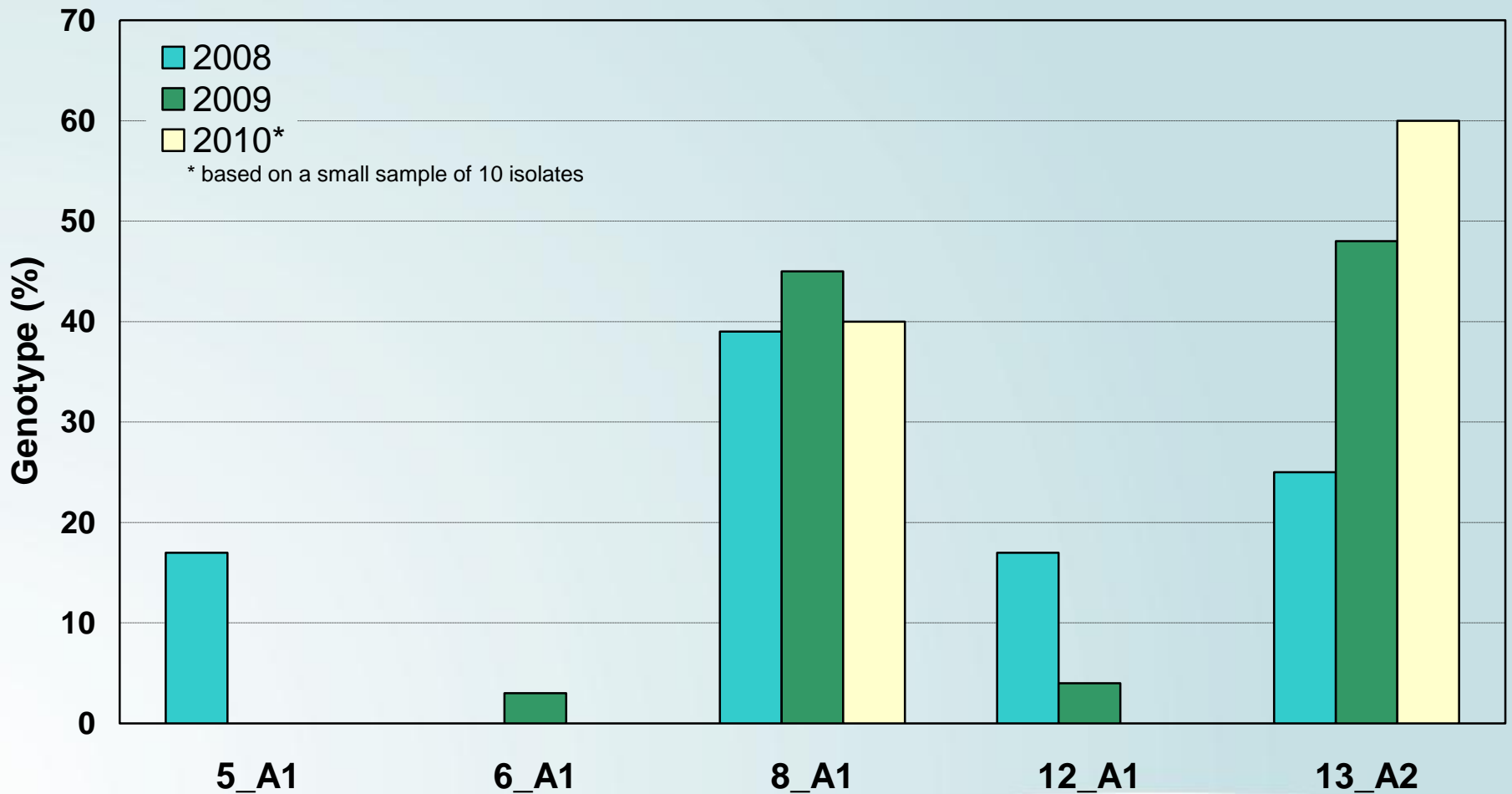
***Phytophthora infestans* genotyping**

Northern Ireland

- *Population dominated by 2 genotypes*
 - *8_A1 = NI-1/IE-1, Pep 100/100, mtDNA IIa S(R), commonest type in 1990s*
 - *13_A2 = Blue 13, Pep 96/96, mtDNA Ia R, first found in 2007*

Phytophthora infestans genotyping

Genotypes of Northern Ireland *Phytophthora infestans* isolates, 2008-2010



***Phytophthora infestans* genotyping**

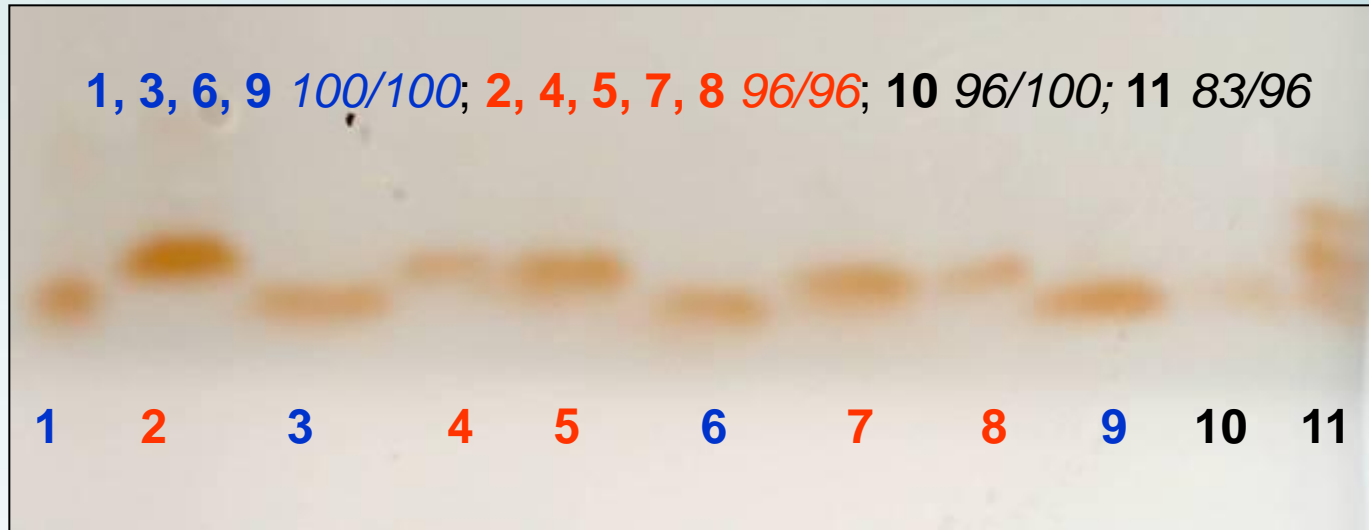
Pep allozyme genotypes

- *Pep 100/100: 8_A1 and other 'older' genotypes*
- *Pep 96/96: 13_A2, 6_A1 new genotypes*

Phytophthora infestans genotyping

Pep allozyme genotypes

- *Pep 96/96* confirmed by comparison with standards from Hungary and Japan (thanks to József Bakonyi and Seishi Akino)



1 US-11; 2 Hungarian; 3 Ireland 8_A1; 4 JP-1; 5 Ireland 13_A2; 6 LD151 8_A1;
7 Ireland 13_A2; 8 JP-1; 9 Ireland 8_A1; 10, 11 Hungarian

- Supports view that Blue 13 and Pink 6 are migrants into Ireland: *Pep 96* allele extremely rare before 2007 (only found in 7 isolates)

Phytophthora infestans genotyping

Allozyme genotypes

- *Gpi*
 - 2009-2011: 75 isolates, all 100/100
- *Pep*
 - 2009: 63 isolates, 32 - 96/96, 31 - 100/100
 - 2010: 18 isolates, 16 - 96/96, 2 - 100/100
 - 2011: 45 isolates, 1 - 96/96, 44 - 100/100

Phytophthora infestans genotyping

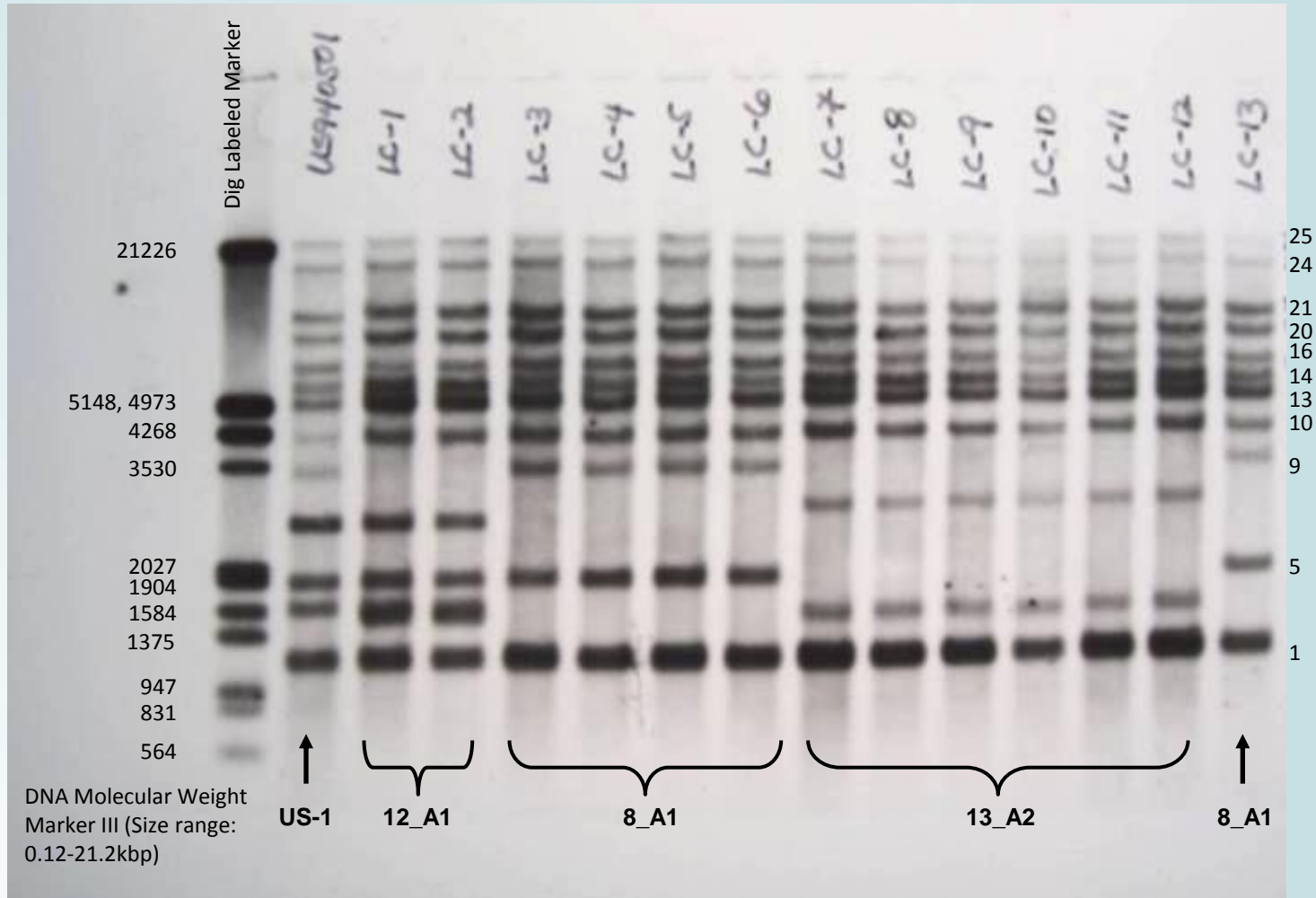
RG57 genotypes

- *RG57 genotypes*
 - *5_A1, 8_A1 older genotypes*
 - *13_A2, 6_A1 new genotypes*
 - *12_A1*
- *66 isolates from 2009 and 2010 fingerprinted to date*

| Location | Year | 5_A1 | 6_A1 | 8_A1 | 12_A1 | 13_A2 | Total |
|----------|------|------|------|------|-------|-------|-------|
| Rol | 2009 | 3 | 11 | 7 | 0 | 16 | 37 |
| NI | 2009 | 0 | 1 | 8 | 2 | 8 | 19 |
| | 2010 | 0 | 0 | 4 | 0 | 6 | 10 |
| Total | | 3 | 12 | 19 | 2 | 30 | 66 |

Phytophthora infestans genotyping

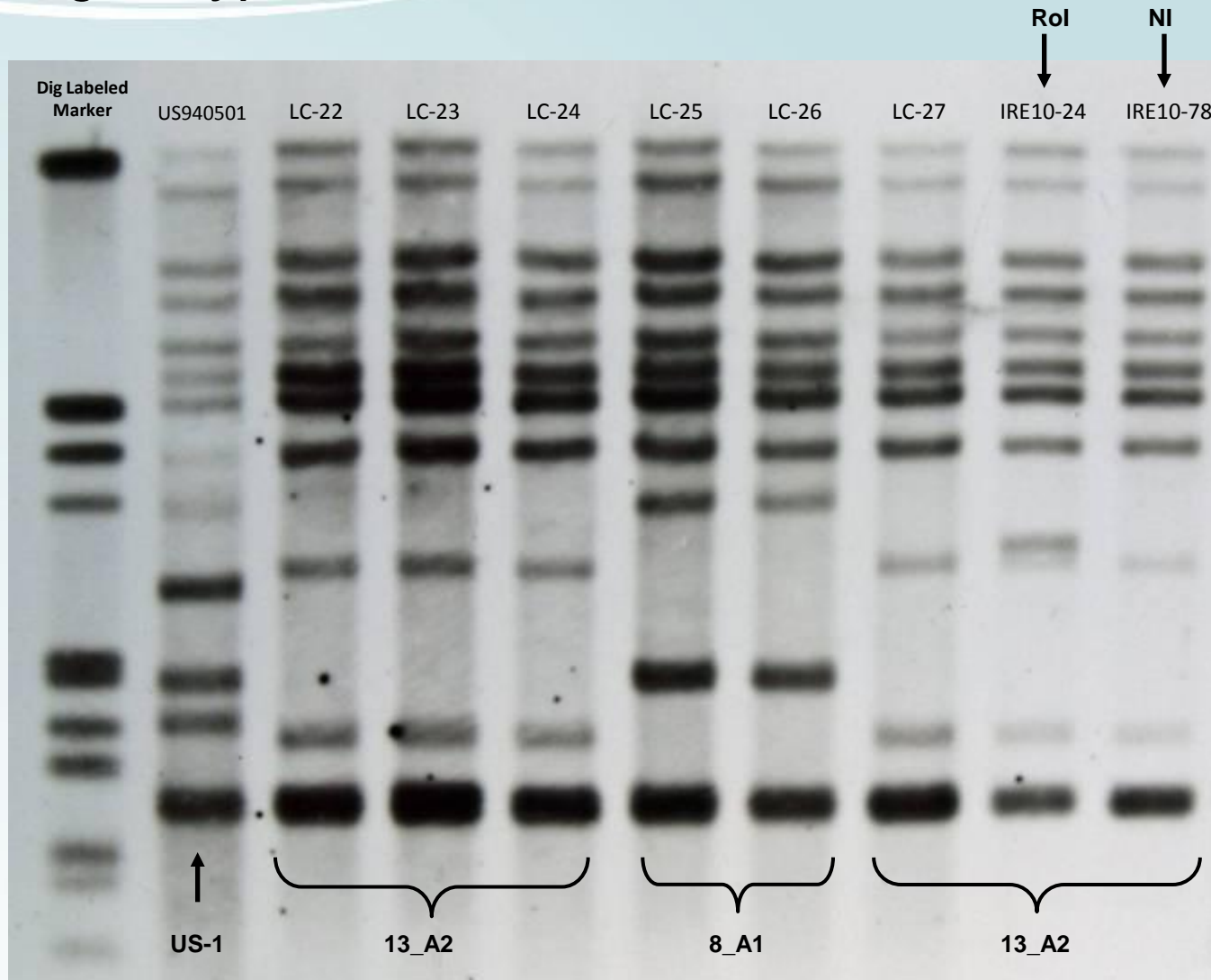
- RG57 genotypes from Northern Ireland 2009-2010



- showing 12_A1, 8_A1 and 13_A2

Phytophthora infestans genotyping

- *RG57* genotypes from NI and Rol 2009

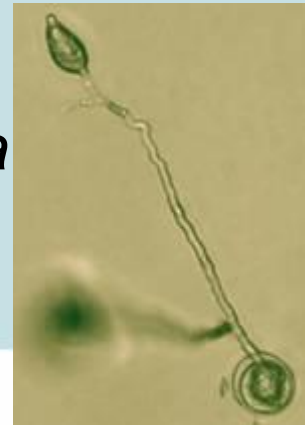


- showing 8_A1 and 13_A2

Phytophthora infestans in Ireland

Comments on changes

- *Population highly clonal: few genotypes*
- *Pink 6, Blue 13 arrived by migration (new SSR alleles, new PEP genotype)*
- *Blue 13 always metalaxyl-resistant, Pink 6 sensitive*
- *Blue 13 is the only A2 genotype, increased from 2007 to 2009, 2010?*
- *So far, Pink 6 hasn't become established*
- *No evidence of recombination, but this remains a possibility (see poster by Moses Nyongesa)*



Phytophthora infestans in Ireland

What happened in 2011?

- *Population has shifted back to A1 (we may find some A2s among remaining isolates)*
- *2010: very dry spring, very little foliar blight, even less tuber blight – **bottle neck!** 2011 A2s not detected so far*
- *Limited evidence suggests population may have reverted to 8_A1 NI-1 (at least in NI)*
- *Parallel situation?*
*1995: hot, dry summer, very little foliar blight, negligible tuber blight – **bottle neck!** Post-1995 A2s not detected*
- ***The *Phytophthora infestans* population in Ireland is still changing!***

Acknowledgements



Department of
Agriculture, Fisheries and Food
An Roinn
Talmhaíochta, Iascaigh agus Bia

Funding
Sample collection



Department of
**Agriculture and
Rural Development**
www.dardni.gov.uk

AN ROINN
Talmhaíochta agus
Forbartha Tuaithe
AN ROINN O
Fairsim an
Kintra Forderin

Funding
Sample collection



Sample collection
Characterisation



Sample collection
Characterisation



Characterisation



The James
**Hutton
Institute**

*David Cooke & Alison Lees
advice on genotyping*