An update on the status of genotype 13 in GB

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Scouts
Potato Council FAB
Scottish Government
Overview

- Survey results for 2009 season
- Local/regional spread of late blight – SSR tagging
- Oospore experiments
- Conclusions & implications
2009 *P. infestans* Population

- 4 leaves per outbreak
- 154 positive outbreaks recorded
- 143 outbreaks with isolates recovered
- 681 samples arrived
- 533 isolates recovered
- 533 mating type tested
- 71.5% A2 mating type
A2 mating type by outbreak

% outbreaks with A2

Outbreak No.

1995-8  2003  2004  2005  2006  2007  2008  2009

SCRI
living technology
Population diversity 2003-9

GB genotypes

Genotype 23_A1 – tomato, petunia & potato. Increase?
Misc – no increase
Regional distribution over time

- **13_A2** spread from South East
- **6_A1** spread from North – origin NL?
13_A2 – SSR variation within clonal lineage

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1500 13_A2 isolates (stable)

13_A2 arrow

other GB genotypes
Variation within genotype 13_A2

• Minor changes in two markers yields distinct genetic ‘signatures’ within 13_A2 blight.

• One type (13_A2_1) dominates the 2003-2009 population

• Can be used to track inoculum spread
Variation within genotype 13_A2 over time

80 minor variants.

Each likely similar properties in field but can be used to track inoculum spread

Over whole of GB the original type (1) from 2006 is declining as new forms emerge.
Variation within genotype 13_A2 by region

- Regional differences in proportion of the different 13_A2 variants.
- Some common to several regions but several distinct to Scotland & Borders.
- ‘founder effect’ i.e. local sources of inoculum important in epidemics
- Geographic distance helps isolate populations
Variation within genotype 13_A2 by region and time

- Type 2 founded Scottish population in 2006 and continues to dominate but rare in Midlands area.
- Type 1 dominates most other regions but is in decline
- Type 5 frequent in Midlands but rare in Scotland
Variation within genotype 13_A2 by Scottish county
Role of oospores?

- 2006 to 2009 both mating types have been found in 1/5 to 1/7 of sampled GB outbreaks.
- We know GB A1 and A2 strains form oospores in the lab & very likely oospores are in GB fields
- Why low frequency of new genotypes in field samples?
- Need for good field data on oospore biology
Main questions

1. Do GB *P. infestans* A1 and A2 genotypes form oospores in GB potato crops?
2. Do these oospores survive in the soil between crops?
3. What is the role of the resultant novel isolates on:
   a) Disease in current crop
   b) Wider population
Experimental set up – four tunnels

Why tunnels?

- Increase number of crop cycles
- Contain spread – between tunnels and beyond
Polytunnels at SRT, Bangor

Dave Shaw
Simon White
Cornelia Bufa
Jonathan Thompson
### Timeline and first cycle infection

**2006**
- AM J JASON O D J F M

**2007**
- AM J JASON O D J F M

**2008**
- AM J JASON O D J F M

**2009**
- AM J J

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- Different pairs of A1 and A2 used to establish blight in each tunnel
- No further introductions of pathogen in cycles 2-5

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<th>2006</th>
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**T1**
- A1 + A2

**T2**
- A1 + A2

**T3**
- A1 + A2

**T4**
- A1 + A2
- A1 + A2

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Cycle 1 infection

- High levels of disease in all tunnels
- Infected leaf samples examined and oospores observed in all tunnels
Parental isolate genotypes

- SSR fingerprints of each isolate distinct
- If sexual recombination occurs we expect to see recombination and re-assortment of the alleles at the markers below
- Some alleles unique to specific isolates

### 11 markers

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Observed crops in Cycle 2

- Dead haulms rotted into soil
- Small tubers possible inoculum source so removed by hand
- Soil kept moist over summer period with misting
- Weeds controlled with herbicide
- A bait-test with soil samples recovered only two isolates and these were of parental type
- Crop planted in October 2007 and inspected daily for blight infection
Genotypes from **Tunnel 2 in cycle 2**

- Blight seen 31 days after planting
- Novel combinations of markers found consistent with 7_A1 parent but also 13_A2 instead of 3_A2 as partner
Location of infection Tunnel 2 cycle 2

Sampled: 2 Nov. 7 Nov. 13 Nov. 19 Nov.

- Type 3 more aggressive?

- new_3
- new_4
Other cycles - general conclusions

- Blight appeared from 37 to 49 days after planting.
- Further novel tunnel-specific genotypes found. None matched those in cycle 2.
- All genotypes absent from the wider GB population.
Oospore conclusions

1. Do GB *P. infestans* A1 and A2 genotypes form oospores in GB potato crops? **YES**

2. Do these oospores survive in the soil between crops? **YES**

Early infections in most crops.

The 500+ isolates recovered from these tunnels over 2 years of 22 genotypes genetically distinct from the parental A1 and A2 isolates and generally specific to a tunnel. This is consistent with germinating oospores.

Many oospores likely generated in cycle 1 but the number that germinated and caused disease pretty low (i.e. 22). Explains poor record of bait testing?
3. What is the role of the resultant novel isolates on:

a. Disease in current crop

Stem and foliar lesions formed but, in general, epidemics spread slowly. Feature of genotypes or environment? Differences in fitness and aggressiveness between types noted. Perhaps new genotypes from these isolates not well adapted.

A few A1 and A2 combinations contributed most of novel markers to new population whereas others combinations had very low viability. Variation related to ploidy or other factors?

b. Wider population

Low fitness amongst progeny in this study consistent with low frequency of ‘misc’ genotypes to date on GB scale. Not the case in other countries.

Threat remains –oospores increase diversity of population and probability of new fitter forms overcoming host or fungicides increased compared to clonal populations. New fit clones generated from such events.
- Pi4B different allele combinations plotted

**205/213** = 13_A2 (370) & 12_A1 (12)

**205/217** = 7&8_A1 (159) & 5_A1 (8)

**213/217** = 6_A1 (63), 3_A2 (34), 10_A2 (31)
Conclusions & Implications

• **Mating types**: Plateau of A2 type and genotype 13 in population. Rise of genotype 6 also apparent.

• **Oospores**: Threat of oospore formation remains. Oospores already in soil remain a risk as fields come back into potato. Evidence that oospores will form and infect in short rotations under GB conditions. Especially relevant as meiosis generates novel combinations of effector genes which may make deployment of any novel resistances challenging.

• **Other primary inoculum**: local inoculum still an issue – stay alert to seed, volunteers and outgrade piles.

• **Disease management**: Ensure robust protection & consider fungicide products carefully in light of population change. Keep on your toes with spray intervals as blight still more active than in the past

• **Questions remain**: - DSS & Smith periods
Associations between genotype and cultivar 2003-8?

- No clear evidence of association – reflects lack of R?