# Phenotypic and genotypic characteristics of Algerian isolates of *Phytophthora infestans*

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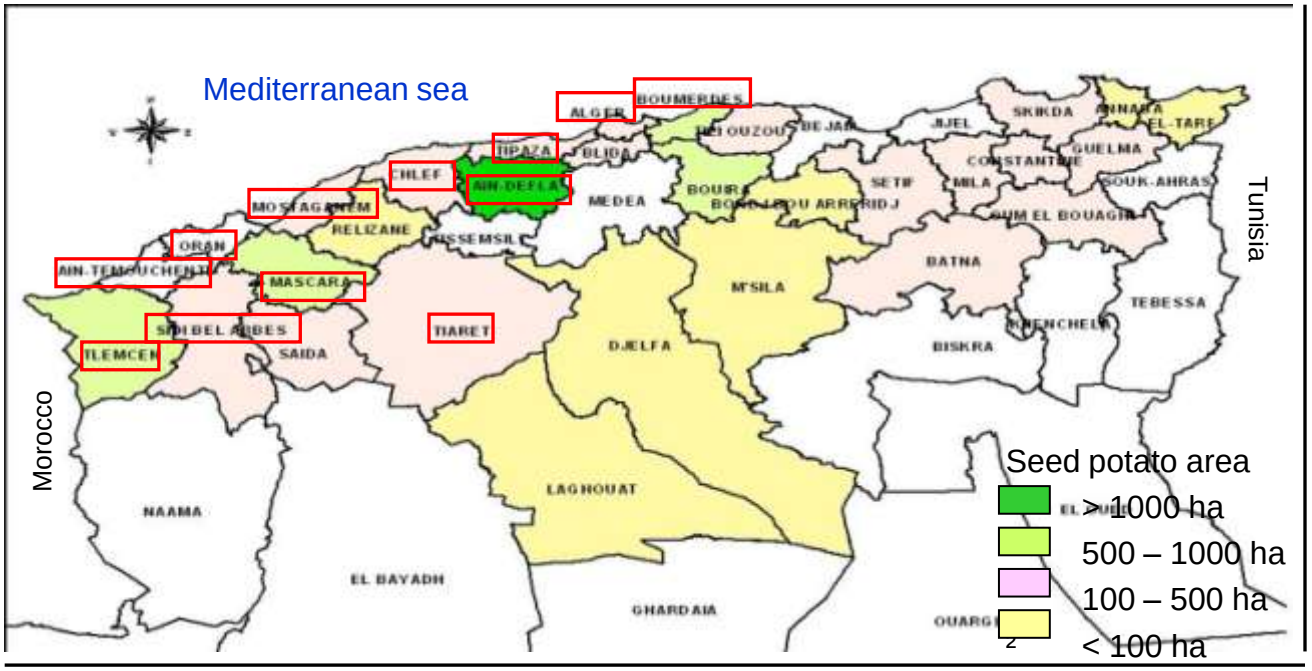
# Knowledge of Algerian *P. infestans* populations is crucial to elaborate control strategies against late blight

Tomato and potato : 2 important crops (90 000 ha potato area)

- Late blight : permanent worry (2007 : very serious epidemics)
- Two or three potato crops per year, in several regions

⇨ *P. infestans* isolates collected in Western and Central Algerian regions between Algies and Oran (360 km).



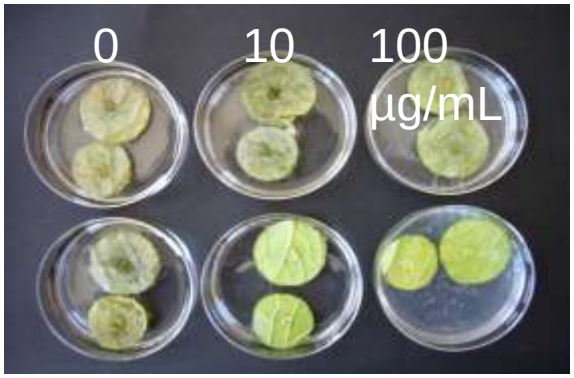
# Origin and mating-types of *P. infestans* isolates from Algeria

| Year | Plant | Number of isolates | Mating-type |
|---|---|---|---|
| 2007 | potato | 9 | 1 A1 + 8 A2 |
| 2008 | tomato | 2 | 2 A1 |
| | potato | 18 | 18 A2 |
| 2009 | potato | 7 | 1 A1 + 6 A2 |

To determine mating-type : pairing test on pea agar medium, with A1 and A2 testers.


- 36 single lesion isolates : one per field
- On different potato cultivars :
  - 14 on Spunta, 5 on Atlas, 2 on Désirée, ….
- **Majority of potato isolates are A2**

# All A2 isolates from potato are resistant to metalaxyl




Resistant isolate

Sensitive isolate

Test : floating leaf disk method, with Bintje cultivar and 2 concentrations of metalaxyl (10 and 100 µg / mL $H_2O$)

| Plant / year | Mating-type | Metalaxyl reaction |
|---|---|---|
| Tomato / 2008 | 2 A1 | 2 Sensitive |
| Potato / 2007 | 1 A1 | 1 Intermediate |
| Potato / 2007- 08 | 25 A2 | 25 Resistant |

**A1 and A2 isolates are different according to their metalaxyl behaviour**

# A2 isolates have highly complex virulence patterns


Virulence : tested on the Black's differential set, each potato clone possessing one or more R1 – R11 pathotype-specific resistant genes from *Solanum demissum.*

| Plant | MT | Name / Isolate | Nb of factors | Not virulent to : |
|---|---|---|---|---|
| tomato | 1 A1 | ITC | 10 | R2 |
| | 1 A1 | AD | 10 | R9 |
| potato | 4 A2 | - | 10 | R9 |
| | 12 A2 | - | 11 | 11 genes overcame |
| | 1 A1 | GH-2007 | 7 | R2, R5, R6, R9 |

Most of Algerian isolates (13/19 tested) possessed virulence to R9, although R9 is unfrequent (or absent) in commercial cultivars

**Tomato and potato isolates are highly virulent, except 1 A1 from potato**

# Temperature effect on mycelium growth

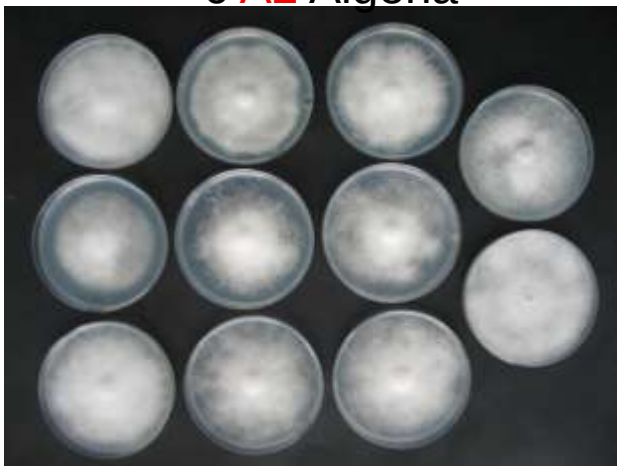
- Pea agar medium
- 5 constant temperatures in darkness : 11 – 15 – 19 – 23 – 27 °C
- Diameter of the colonies (3 cultures per isolate and temperature)
  - after 7 days of incubation at 5 temperatures,
  - after 15 days at 27°C
- 9 Algerian isolates (2 A1 from tomato, 1 A1 potato, 6 A2 potato),
  2 French isolates from potato (1 A1, 1 A2)

6 A2 Algeria

A1 tomato

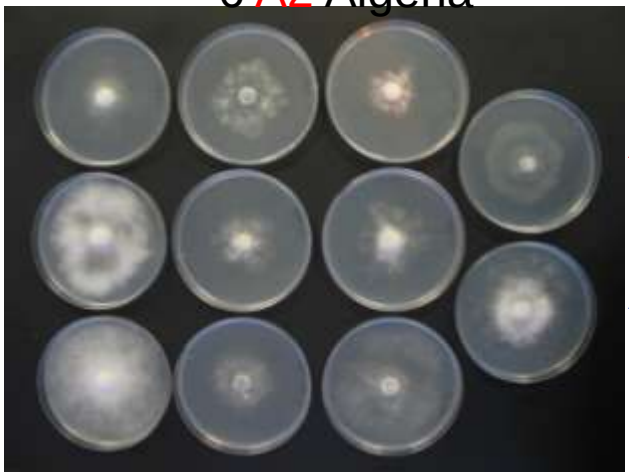
A1 tomato

A1 potato



15°C

6 A2 Algeria



A2 French

A1 French

23°C

# Temperature effect on mycelium growth

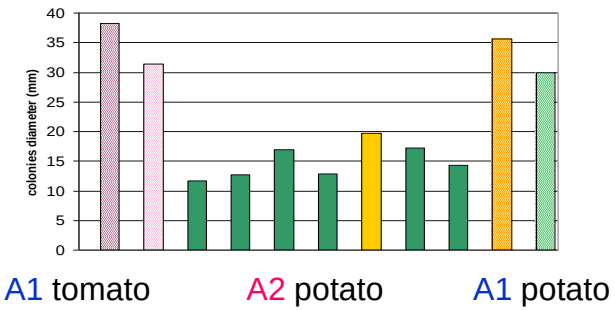
**Pink** : Algerian isolates / tomato (2 A1)
**Green** : Algerian isolates / potato (1 A1 + 6 A2)
**Yellow** : 2 French isolates (1A1 + 1A2)
**Hatched** : A1

7 days

- 19°C : optimal temperature
- 11 and 27°C : growth inhibition
- No difference between Algerian and French isolates

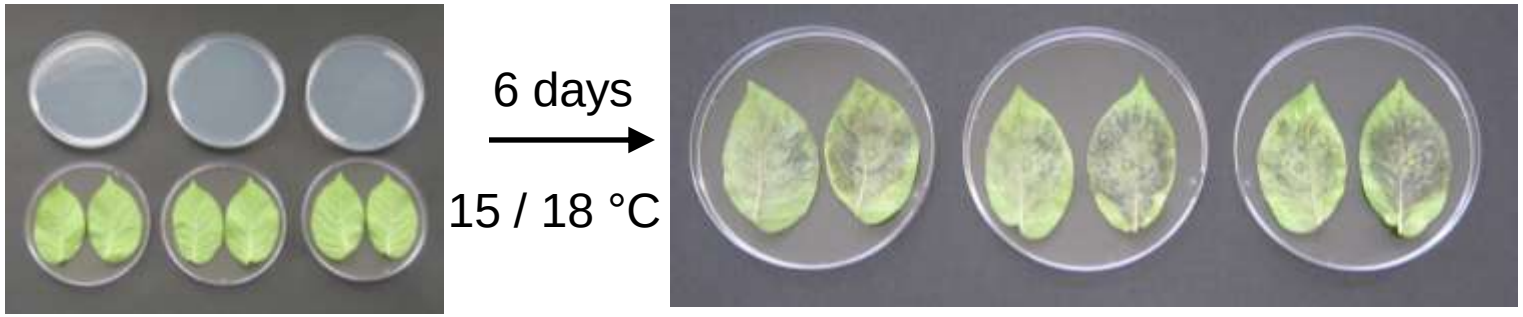
- After 7 days of incubation
  - A1 from potato : important growth
  - 1 A1 from tomato (ITC) : reduced growth, especially at 19°C

15 days at 27°C




- After 15 days of incubation at 27°C
  - A1 isolates grow faster than A2 isolates
  - No difference between A1 from potato and tomato

# Aggressiveness quantification

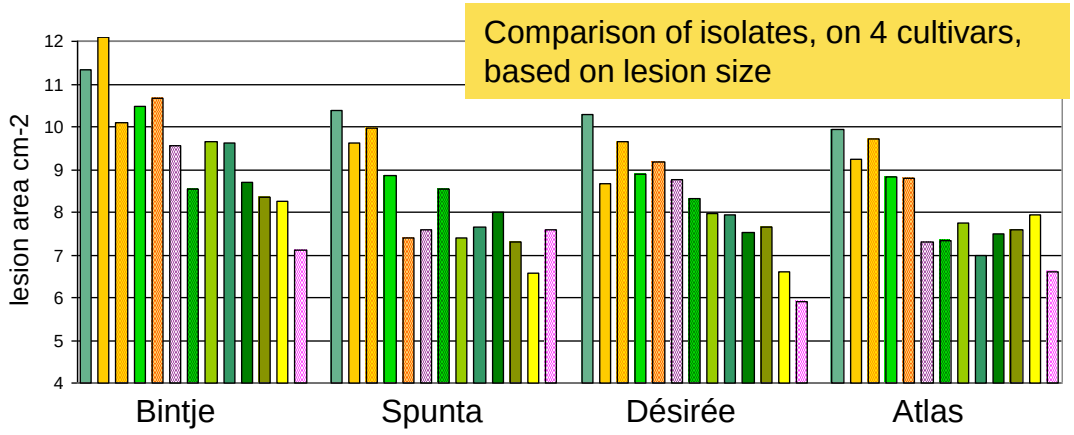


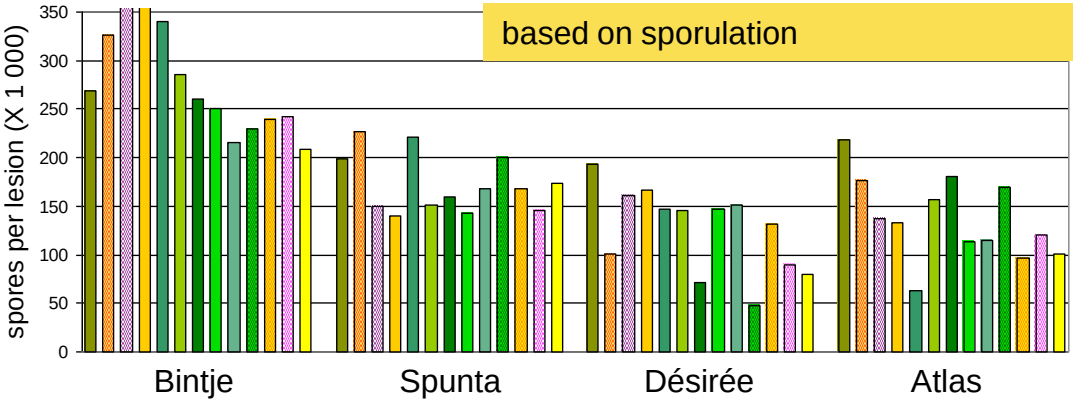

- 13 isolates tested
  - 2 A1 from tomato and 1 A1 from potato
  - 6 A2 from potato, collected in 2008
  - 4 French isolates (2 A1 and 2 A2) for comparison (2008)
- on 4 cultivars
  - Spunta : dominant cultivar in Algeria and susceptible
  - Bintje : susceptible in Europe, not cultivated in Maghreb
  - Désirée and Atlas : moderately susceptible to susceptible
- Aggressiveness components
  - Lesion size
  - Sporangia production per lesion

# Aggressiveness of A1 and A2 isolates from tomato and potato

**Pink** : Algerian isolates / tomato (2 A1) **Yellow** : 4 French isolates (2A1 + 2A2)

**Green** : Algerian isolates / potato (1 A1 + 6 A2) **Hatched** : A1 (5 isolates)




## Isolates

- no difference between
  - A1 and A2
  - Algerian / French populations
- different behaviour according to cultivars and components
  - one A1 from tomato (ITC) is the less aggressive

## Cultivars

- Bintje : the most susceptible cv.
- on Désirée and Atlas, sporulation is twice smaller than on Bintje
- on Spunta, sporulation is greater than on Désirée and Atlas

# Genotypic characteristics

- 10 microsatellite markers (SSR)

- 18 Algerian isolates from 2007 and 2008
  - 2 A1 from tomato
  - 1 A1 from potato
  - 15 A2 from potato

# Genotypic characteristics

| Sample Name | MT | plant | Year | MLG | Pi02 | Pi02 | Pi89 | Pi89 | Pi4B | Pi4B | G11 | G11 | Pi04 | Pi04 | Pi70 | Pi70 | Pi56 | Pi56 | Pi63 | Pi63 | Pi16 | Pi16 | Pi33 | Pi33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DZ-AD | A1 | tomato | 2008 | MLG 200 | 162 | 164 | 179 | 181 | 213 | 217 | 162 | 162 | 160 | 168 | 192 | 195 | 174 | 174 | 148 | 157 | 176 | 178 | 203 | 203 |
| DZ-ITC | A1 | tomato | 2008 | | 162 | 164 | 179 | 181 | 213 | 217 | 162 | 162 | 160 | 168 | 192 | 195 | 174 | 174 | 148 | 157 | 176 | 178 | 203 | 203 |
| DZ-GH-2007 | A1 | potato | 2007 | MLG 201 | 152 | 162 | 179 | 179 | 217 | 217 | 156 | 156 | 166 | 170 | 192 | 195 | 174 | 176 | - | - | 176 | 178 | 200 | 200 |
| DZ-G28 | A2 | potato | 2008 | MLG 3 | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 200 | 200 |
| DZ-G33 | A2 | potato | 2008 | | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 200 | 200 |
| Z33 | A2 | potato | 2008 | MLG 202 | 162 | 162 | 179 | 181 | 217 | 217 | 140 | 140 | 166 | 170 | 192 | 192 | 176 | 176 | 151 | 157 | 176 | 178 | 203 | 206 |
| DZ-AT | A2 | potato | 2008 | MLG 7 | 160 | 162 | 179 | 179 | 205 | 205 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| Z13 | A2 | potato | 2007 | MLG 67 | 162 | 162 | 179 | 179 | 205 | 205 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 178 | 178 | 203 | 203 |
| Z18 | A2 | potato | 2007 | | - | - | 179 | 179 | - | - | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 178 | 178 | 203 | 203 |
| Z12 | A2 | potato | 2007 | MLG 203 | 162 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 178 | 178 | 203 | 203 |
| Z32 | A2 | potato | 2008 | MLG 204 | 162 | 162 | 179 | 179 | - | - | 160 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 178 | 178 | 203 | 203 |
| Z21 | A2 | potato | 2007 | | - | - | 179 | 179 | - | - | 160 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | - | - | 178 | 178 | 203 | 203 |
| DZ-TLE | A2 | potato | 2008 | MLG 34 | 162 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| Z3 | A2 | potato | 2007 | | 162 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| DZ-SABL | A2 | potato | 2008 | MLG 1 | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| Z0 | A2 | potato | 2007 | | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| Z1 | A2 | potato | 2007 | | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |
| DZ-ABD | A2 | potato | 2008 | | 160 | 162 | 179 | 179 | 205 | 213 | 154 | 160 | 166 | 170 | 192 | 192 | 174 | 176 | 151 | 157 | 176 | 178 | 203 | 203 |

- A1 and A2 are two different populations
  - A1 from tomato are different from A1 from potato
  - Several rare alleles found in Algerian isolates, e.g. from tomato
- A2 : many multi-locus genotypes (MLG) : 8 for 15 isolates
  - Some MLG not presently detected in France

# Conclusion

- On potato : majority of A2 isolates, as in France
  - A2 are different from A1
    - SSR markers reveal 2 distinct populations
      - A2 : great genetic diversity, but no structuration according to the year
    - A2 : metalaxyl resistant, A1 : sensitive or intermediate
    - With very complex virulence patterns, but no relationship between virulence and genotypes
  - These results are consistent with data from French populations.
- **But** no difference for aggressiveness between A1 and A2, in our experimental conditions.
- On tomato : *P. infestans* isolates seems different from potato isolates.

  Need confirmation with large samples
    - The 2 A1 isolates : genetically similar, but phenotypically different (mycelium growth, virulence, aggressiveness)
- Is sexual reproduction present in Algeria ?
    - Oospores in soil ?
    - New populations ?

# Conclusion

- Mycelium growth on medium
  - Best températures : 15°C and 19°C (optimal)
  - Some differences between A1 and A2 isolates
  - **But** no differences between Algerian and French populations

➡ Algerian isolates : not adapted to warm temperatures.

- Virulence can't explain the invasion by A2 isolates,

  as they overcome most or all resistance genes from *S. demissum*, including those which have not been introduced into potato so far (e. g. R9).

➡ Other life history traits, possibly related to environmental or climatic changes should now be considered.

- Development of integrated management strategies is crucial in Algeria ; durable partial resistant cultivars should be very usefull to control LB
  - as Spunta, dominant cultivar, is very susceptible.
  - Désirée and Atlas are also susceptible, althought sporulation of isolates is reduced.

# *Thank you !*

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