Analysis of potato volunteer density under the influence of cropping practices:
a contribution to the modelling of *Phytophthora infestans* primary inoculum production

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Integrated management of late blight

Need for a description of primary inoculum sources

Major sources

- Infected seeds: difficult to quantify
- Soil/Oospores: no evidence in France
- Volunteer potatoes
  - In commercial fields: from tubers left in soil after potato harvest and growing as weeds in succeeding crops
  - In waste piles: from tubers in outgrade piles and discard heaps

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Volunteers in fields and piles

- Volunteer potatoes in commercial fields:
  - Growing concern
  - Found in production situations with mild winters
  - May emerge throughout the entire year, especially in cool and coastal locations
  - Difficult to control with herbicides

- Waste piles not always well controlled
Aim: quantify the potential sources of primary inoculum

Main sources

Volunteers in fields  Waste Piles

- Agronomic objective: quantification of the density of volunteer potatoes in a wide range of production situations to take into account the effects of climate, cultivar and other cultural practices:
  - In commercial fields
  - In waste piles

- Methodological objective: design of a sampling strategy
Method: quantification of potato volunteer density

Sampled units
- Commercial fields with potato crop the previous year, in Brittany
- Waste piles, in North-Pas de Calais & Picardie

Methods
- Quadrat counts (1 m²) randomly distributed in fields or piles
- Field and pile size measurements
- Survey of farmers

Variables
- Density: number of potato stems per surface unit (m⁻²)
- Field and pile areas (m²)
- Cropping practices (data not shown)
Method: quantification of volunteer density in two different production areas

In Brittany, on May 2010 and May 2011
Mild winters, oceanic climate
in cereals and grass fields
near Brest 1 and Landivisiau 2
wheat (18), barley (5), maize (7) and ray-grass (3)
in 13 fields, uncultivated field, at the time of sampling
St Pol de Léon 3
in 18 artichoke fields
near Paimpol 4

In North-Pas de Calais & Picardie, on May 2011
« Cold » winters
in 34 potato piles
Method: determination of the number of quadrats to observe as a function of potato volunteer density to achieve a given precision

- Number of quadrats to observe: determined by the simulation
- Fields with a given volunteer density were simulated, assuming that potato stems were spatially randomly distributed.
- These fields were sampled several times using $n$ quadrats. This was repeated for various densities.
- This permitted to assess the relationship between the precision on quadrat counts and volunteer density, for various sampling sizes.
Results: Number of quadrats to observe
determined by simulation

if 0.1 ≤ d < 0.5 then nb = 40 (cv ≈ 40 %)
if 0.5 ≤ d < 1.0 then nb = 40 (cv ≈ 20 %)
if 1.0 ≤ d < 3.0 then nb = 30 (cv ≈ 15 %)
if d ≥ 3, then nb = 20 (cv ≈ 10 %)

d : volunteer density (m⁻²)

nb : number of quadrats used for sampling

cv : coefficient of variation on the density
(Mean and standard deviation of 300 experiment replicates)
North-Pas de Calais waste piles (4 May 2011)
Density of volunteers in piles in North-Pas de Calais and Picardie - 2-5 May 2011

- High density of volunteers before the emergence of adjacent potato fields
- No difference between the 2 locations
- Late blight inoculum observed on 1 pile in North-Pas de Calais
- Bigger piles in North-Pas de Calais than in Picardie
Volunteers in Brittany fields

In **artichoke** field

In **barley** field

In **maize** field
Volunteer density in Brittany fields as a function of years and locations

- Volunteer density depends on
  - year
  - location
  - fields in each location
- 1 blighted plant observed in a wheat field, in Landivisiau, 2011
- Fields near Brest / Landivisiau compared to St Pol / Paimpol:
  - smaller density of volunteers
  - greater areas

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Volunteer density in Brittany fields as a function of the crop following the potato

- Volunteers in all crops
- Volunteer density depends on the crop
  - Highest in artichokes: no chemical treatment, but mechanical weed removal
  - Lowest in ray-grass and barley: efficient competitive crops
  - Intermediate
    - Wheat: less competitive than barley
    - Maize: herbicides
    - Bare soil
- Less volunteers in cereal crops than in other crops
Conclusion and perspectives (1)

- A mathematical tool was proposed to help decide the sampling size as a function of potato volunteer density
  - Useful tool for optimal spatial sampling
  - Realistic, due to time constraint for collecting data.
- Original data: Volunteer density was quantified for a wide range of production situations.
  - Found in all crops
  - Density is variable according year, crop and fields for the same crop
- Limit: volunteers were observed only once
Conclusion and perspectives (2)

○ Need for a model that simulates volunteer dynamics as a function of cropping practices and climate.

○ Coupled with an epidemiological model, this model will help design integrated management strategies of potato late blight (SIPPOM model – Simulator for Integrated Pathogen Population Management - Lô-Pelzer et al., 2008).

○ It will also allow to improve the French DSS as it will make possible to better quantify primary inoculum.

○ This volunteer density simulator could help design control strategies for other potato pests than *P. infestans*.
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