



# PRACTICAL ASPECTS OF INSPECTIONS AND SURVEYS FOR THE PRESENCE OF RELEVANT POTATO PESTS: SOIL-BORNE PATHOGENS (FUNGI AND NEMATODES)

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# MEANS OF SPREADING NEMATODES

## SOIL

- ❧ Farm machinery, equipments, tools, clothes, shoes and gloves
- ❧ Impurities, soil moved by rain or irrigation
- ❧ Wastes of tuber and seed processing

## WATER

- ❧ Rain or irrigation

## SEEDS

- ❧ Impurities = external contamination
- ❧ Inside = as quiescent nematode specimen

## ROOT AND LEAVES CONTACT

# MEANS OF SPREADING NEMATODES



Photo: G. Curto

**By soil residues on farm machinery, equipments and tools**



# MEANS OF SPREADING NEMATODES

## PARTS OF PLANT

- ☞ Root fragments
- ☞ Cultivation wastes
- ☞ Plant materials in export as scions, bulbs, seedlings, roots



# MEANS OF SPREADING NEMATODES



**Wastes of potato tubers  
processing**

# THE AIM OF INSPECTION

- ❧ Determination of risk of introduction and spread of harmful organisms
  - ❧ Determination of pest distribution in the country (early detection of outbreaks)
  - ❧ If found, eradication measures
  - ❧ Reporting (EU, MS, IPPC, EPPO)
- 
- ❧ The control system for potato shall include all the steps in the production and marketing chain
  - ❧ it is an integrated system of inspections and lab analyses
  - ❧ sampling shall be carried out during all phases of production, processing and marketing of potatoes
  - ❧ sampling shall be utilized also in monitoring of the territory where potato is grown.



# QUARANTINE HARMFUL ORGANISMS OF POTATO BY SAMPLING

- ❧ *Ralstonia solanacearum*
- ❧ *Clavibacter michiganensis* subsp. *sepedonicus*
- ❧ *Synchytrium endobioticum*
- ❧ *Globodera pallida* and *G. rostochiensis*
- ❧ *Meloidogyne chitwoodi* and *M. fallax*
- ❧ *Ditylenchus destructor*

1. before planting
2. during growing season
3. during harvesting
4. during storage, trade and processing period

# CONTROL OF THE POTATO PRODUCTION BEFORE PLANTING

## Sampling

- ☞ Soil of fields for potato production
- ☞ Seed-potato tubers for planting

## Soil sampling for:

### A) NEMATOLOGICAL ANALYSIS

- ☞ *Globodera pallida* and *G. rostochiensis*
- ☞ *Meloidogyne chitwoodi* and *M. fallax*

### B) MYCOLOGICAL ANALYSIS

- ☞ *Synchytrium endobioticum*



# POTATO CYST NEMATODES

## *Globodera rostochiensis* and *G. pallida*

### [Council Directive 2000/29 CE of 8 May 2000](#)

#### ANNEX I.A.II

on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community

### [Council Directive 2007/33/EC of 11 June 2007](#)

on the control of potato cyst nematodes and repealing Directive 69/465/EEC

#### [EPPO A2 List](#)

*Globodera pallida* A2/124

*Globodera rostochiensis* A2/125

# POTATO CYST NEMATODES

## *Globodera rostochiensis* and *G. pallida*

### [Council Directive 2007/33/EC of 11 June 2007](#)

on the control of potato cyst nematodes and repealing Directive 69/465/EEC

This Directive establishes the measures to be taken by the Member States against *Globodera pallida* and *Globodera rostochiensis*, known as ‘potato cyst nematodes (PCNs)’, in order:

- to determine their distribution,
- to prevent their spread,
- to control them.

# POTATO CYST NEMATODES

## *Globodera rostochiensis* and *G. pallida*

### Article 4

1. Member States shall prescribe that an official investigation for the presence of potato cyst nematodes shall be carried out on the field in which the plants listed in Annex I, are to be planted or stored.

These plants should be intended for the production of plants for planting, or seed potatoes intended for the production of seed potatoes.

# POTATO CYST NEMATODES

## *Globodera rostochiensis* and *G. pallida*

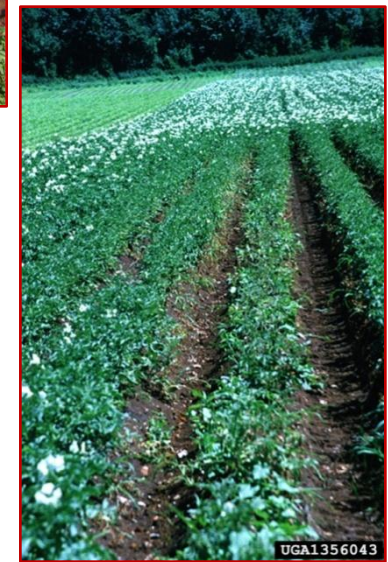
## ANNEX 1 - LIST OF PLANTS

- **Host plants with roots:** *Capsicum* spp., *Lycopersicon lycopersicum* (L.) Karsten ex Farw., *Solanum melongena* L.
- **Other plants with roots:** *Allium porrum* L., *Beta vulgaris* L., *Brassica* spp., *Fragaria* L., *Asparagus officinalis* L.
- **Bulbs, tubers and rhizomes, grown in soil and intended for planting, of:** *Allium ascalonicum* L., *Allium cepa* L., *Dahlia* spp., *Gladiolus* Tourn. Ex L., *Hyacinthus* spp., *Iris* spp., *Lilium* spp., *Narcissus* L., *Tulipa*



# POTATO CYST NEMATODES

## *Globodera rostochiensis* and *G. pallida*

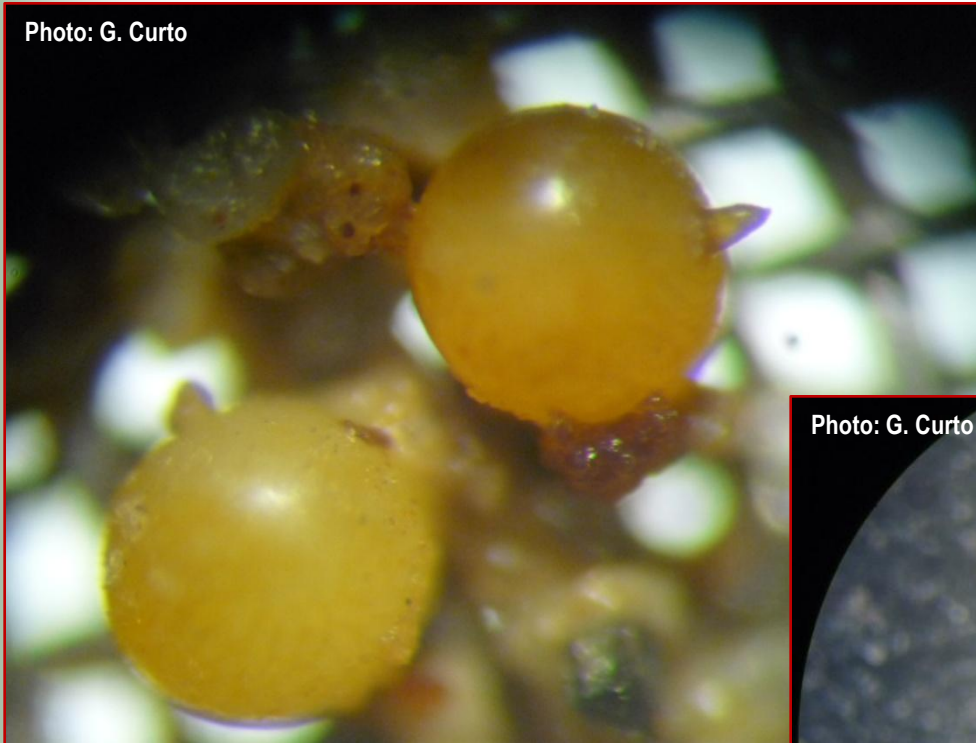


Females and cysts of *Globodera*, symptoms on potato crop

# POTATO CYST NEMATODES

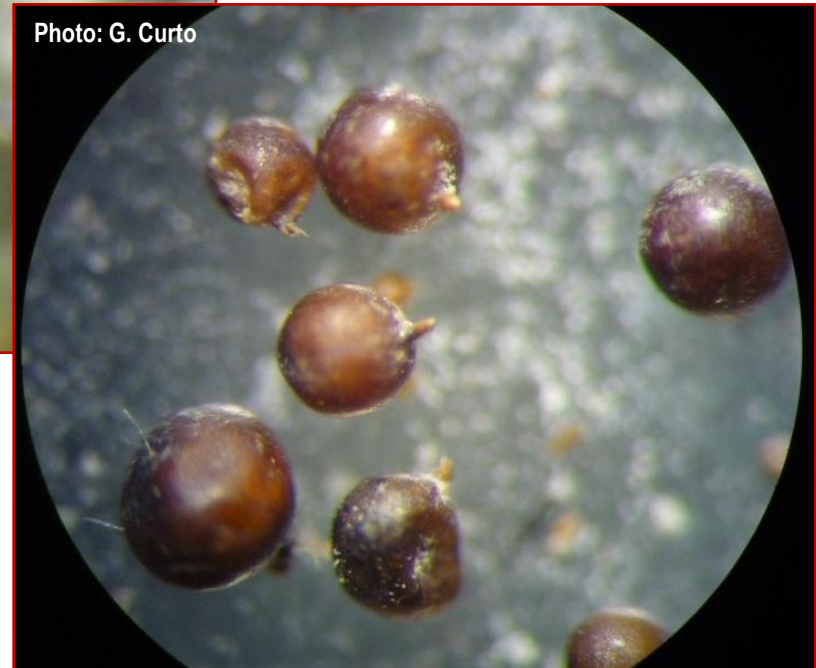
## *Globodera rostochiensis* and *G. pallida*

Photo: G. Curto



Females and cysts of *Globodera rostochiensis*

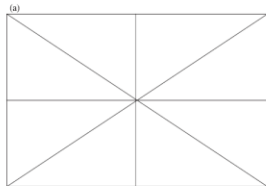
Photo: G. Curto



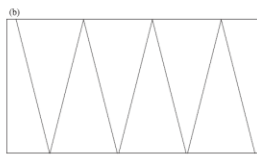
# OFFICIAL INVESTIGATIONS

- The official investigation shall be carried out in the period between the harvesting of the last crop in the field and the planting of seed potatoes.

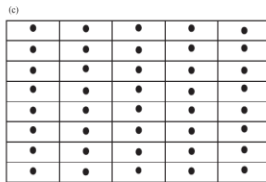
**Timing: between the last harvest and the planting of seed potato**



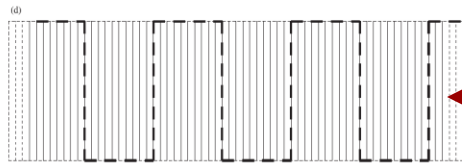
← Sampling along the diagonals of the plot coring the ground following a star pattern



← Soil sampling by following a zig-zag pattern, in order to obtain a uniform coverage



← Sampling and collection of samples according to a grid of 100 m<sup>2</sup> (about 16.7 m x 6 m)



← Soil sampling according to a grid (can also be used with crop in place)

The sampled plots must always be **geo-referenced with GPS or however identifiable on a map.**

The sampling must be taken by a probe, collecting the soil to a **depth of 25-35 cm**, as this is the layer with the roots attacked by nematodes.



# SOIL SAMPLES AND ANALYSIS



Photo: G. Curto

Depth of sampling:  
**25-30 cm**  
Diameter of corer:  
**5-6 cm**

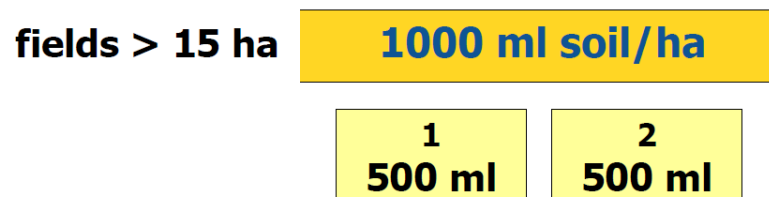
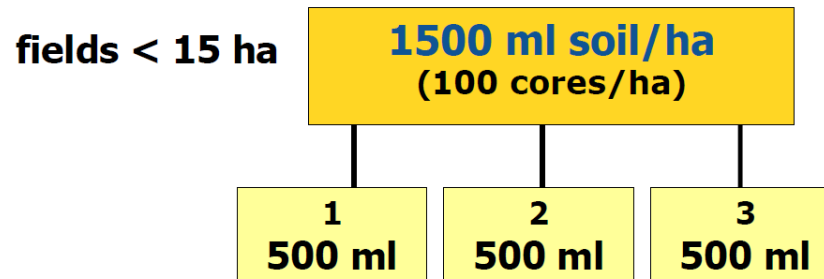




# SAMPLING BEFORE PLANTING

Soil sampling of the plots for seed potato production to analyse in laboratory, for detecting:

- ☞ *Globodera pallida* and *G. rostochiensis*
- ☞ *Meloidogyne chitwoodi* and *M. fallax*
- ☞ *Radopholus similis*
- ☞ *Synchytrium endobioticum*



# SOIL SAMPLING METHODOLOGY

- ☞ Land area < 1 ha: 1 sample formed of at least 10 individual samples
- ☞ Land area > 1 ha: 1 sample formed of more sub-samples each formed by 40-50 individual samples
- ☞ The soil is collected at a depth of 25-35 cm as for PCN as for *Synchytrium endobioticum*



# SAMPLE PREPARATION

Mix the soil collected with the individual samples




- ☞ Form a sample of 2-3 kg of soil
- ☞ Keep the sample in a plastic bag at 4-6°C until it reaches the laboratory



# SAMPLING OF THE POTATO CROP DURING GROWING SEASON

**VISUAL INSPECTION and SOIL SAMPLING** for  
nematological and mycological analyses

Visual examinations of the crop in the field and,  
if appropriate, sampling for laboratory tests, to  
detect harmful organisms:

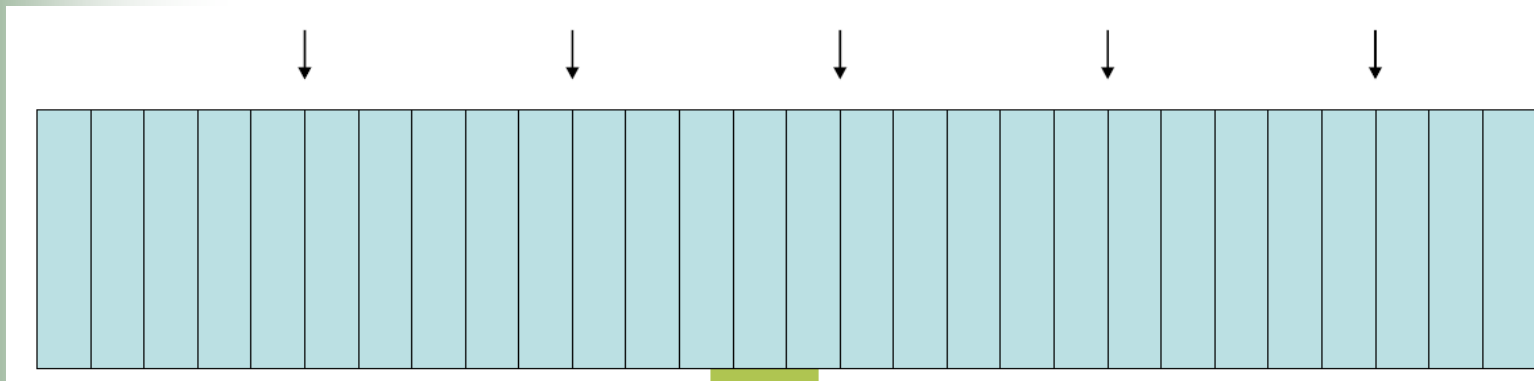
-  *Globodera pallida* and *G. rostochiensis*
-  *Meloidogyne chitwoodi* and *M. fallax*
-  *Synchytrium endobioticum*



# SAMPLING OF THE POTATO CROP DURING GROWING SEASON

## NEMATOLOGICAL ANALYSIS

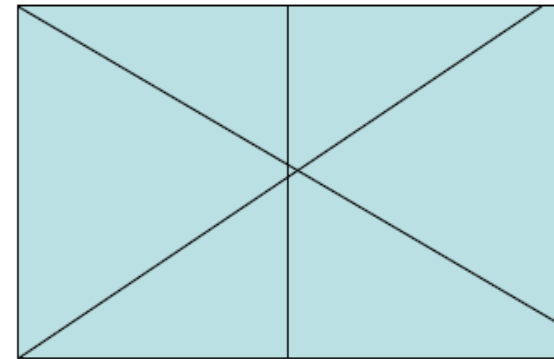
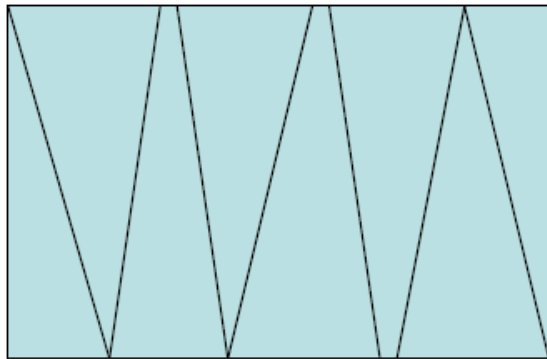
- ☞ 50 sub-samples/ha
- ☞ Every 5 rows, 10 sub-samples are collected along the plants row



# SAMPLING OF PLANTS AND TUBERS

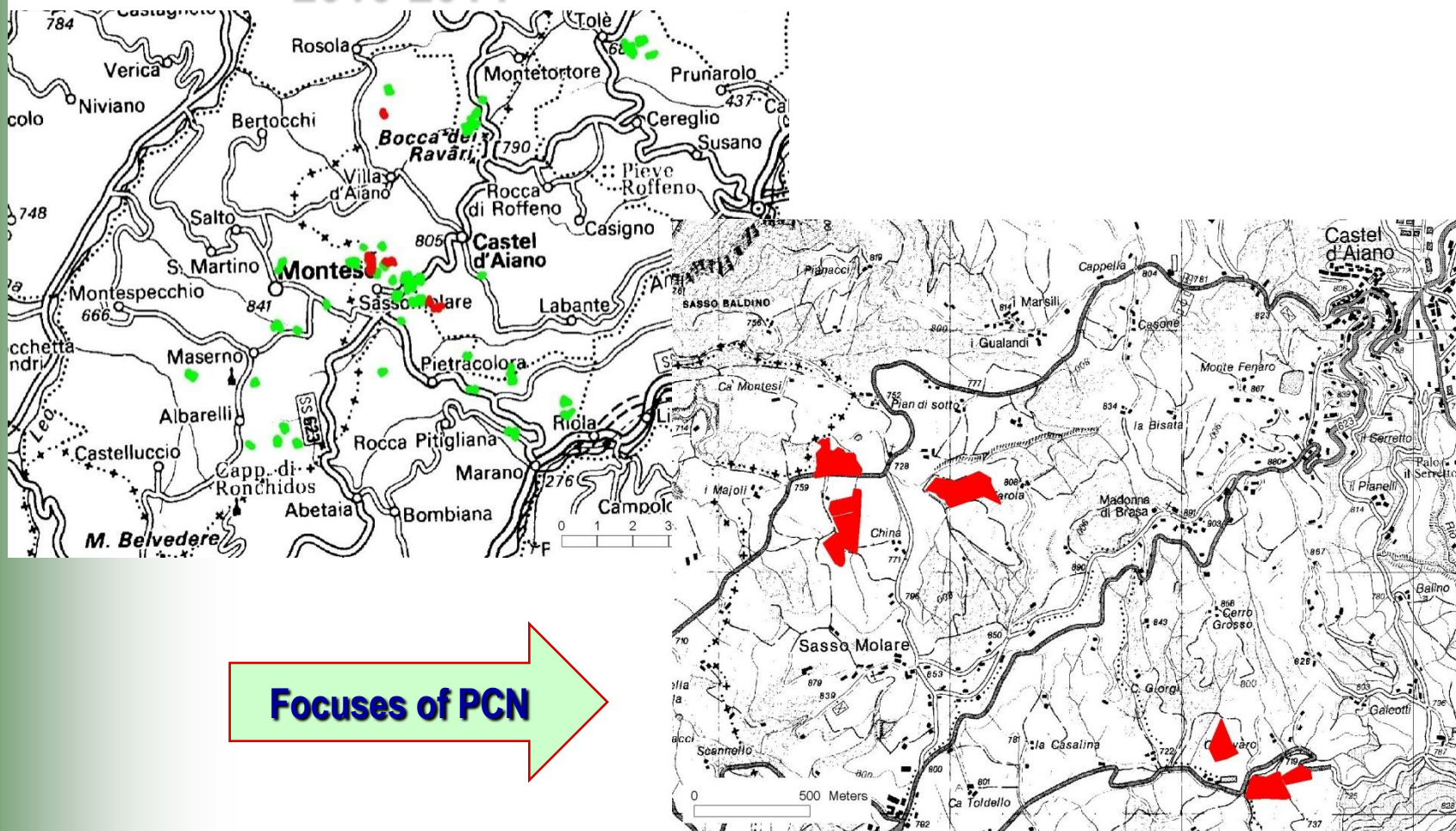
☞ **SAMPLING OF PLANTS** for nematological and bacteriological analyses

☞ Estirpation of 50 plants per hectar with a randomized scheme



# OFFICIAL INVESTIGATION - PCN MAP

2010-2014



Focuses of PCN

# SAMPLING OF DRAIN AND IRRIGATION WATERS

**This sampling is compulsory for bacteria, but it can be useful also for cysts and 2<sup>nd</sup> stage juveniles of nematodes**

- ☞ It is preferable to sample on water having a temperature higher than 15 °C**
- ☞ When sampling wastewaters, the sample shall be collected near the points of emission of the water**
- ☞ The maximum amount of each sample should be 500 ml**

# SAMPLING DURING POTATO PROCESSING AND STORAGE

Visual examinations of tubers and, if appropriate, sampling to potato processing wastes and waste water , to detect:

- ❧ Bacteria (*Clavibacter michiganensis* subsp. *sepedonicus*; *Ralstonia solanacearum*)
- ❧ *Synchytrium endobioticum*
- ❧ *Meloidogyne chitwoodi* and *M. fallax*
- ❧ *Ditylenchus destructor*
- ❧ Viruses TSWV, PSTVd

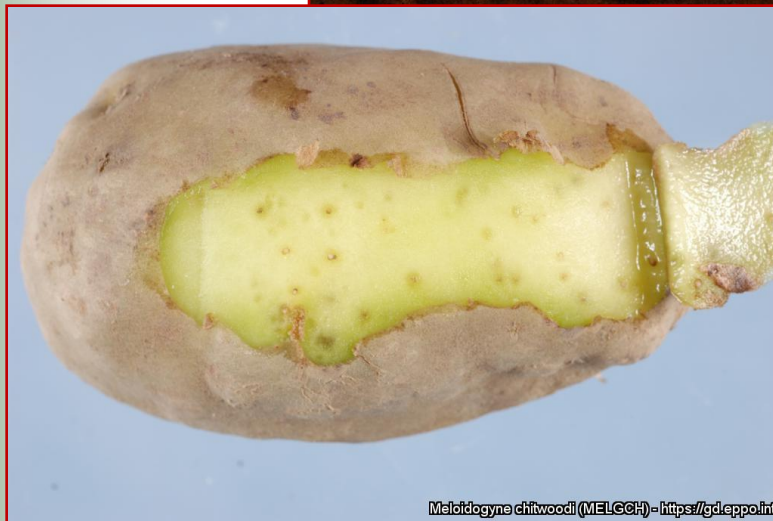


# POTATO ROOT-KNOT NEMATODES

## *Meloidogyne chitwoodi* and *M. fallax*



Symptoms  
on tubers



*Meloidogyne chitwoodi* (MELGCH) - <https://gd.eppo.int>



*Meloidogyne fallax* (MELGFA) - <https://gd.eppo.int>

# POTATO TUBER (ROT) NEMATODE

## *Ditylenchus destructor*

### Symptoms

There are no clear symptoms on the leaves and stems, but infested tubers produce weak plants destined to die.

Early infestation can be detected by peeling the tuber which can reveal small, off-white spots in the healthy flesh.

In very infested tubers sunken areas with cracked and wrinkled skin appear.



*Ditylenchus destructor* (DII/YDE) - <https://gdleppol.it>



# SAMPLING DURING POTATO GROWING SEASON PROCESSING AND STORAGE



A heavily infected plant showing yellowish warts on subsoil tubers and greenish warts at soil level.

HLB B.V., Wijster (NL)



Newly harvested, warted potato tubers of cv. Duke of York; note that some warts are already starting to rot.  
Central Science Laboratory, York (GB) British Crown



*Synchytrium endobioticum*

# VISUAL INSPECTIONS

Symptomless samples

➡ IMPORTATION IS ALLOWED

Suspicious samples

➡ RAPID TEST AND SENT TO LABS

**CONFIRMED INFECTION:  
IMPORTATION IS BANNED**



- the hard copy of the Egyptian certificate is canceled, with a red stamp;
- adoption of proper phytosanitary measures





# SAMPLING DURING POTATO PROCESSING

## **SAMPLING OF SEWAGE SLUDGE, SOIL AND SOLID WASTE**

The analysis of these materials is recommended for the monitoring of the potato production chain

- ☞ About 1 kg of waste material has to be collected from different areas of waste aggregation. All the sub-samples have to be mixed, to homogenize the final sample

## **SAMPLING OF SOIL ADHERING ON TUBERS**

- ☞ After brushing or washing the tubers, collect 0.5 – 1 kg of soil and keep the sample at 12-15°C before analysing it for root-knot nematodes or drying it for the cyst extraction

# PHYTOSANITARY MEASURES

- In a field infested with PCN it is **not possible**:
  - ✓ planting potatoes for the seed production;
  - ✓ implant or storing host plants of tomato, aubergine and pepper intended for replanting
  
- The infested plots, intended for growing of **ware potatoes**, are subject to an **official program of PCN control** aiming to eradicate them

# PHYTOSANITARY MEASURES TO THE FARMS

## The **infested fields**:

- must not be used, **for at least 12 years**, in the production of seed potatoes and plants intended for replanting of tomato, aubergine, pepper;
- must not be used, **for at least six years**, in the cultivation of ware potato varieties, hosts of PCN;
- cannot be used for the production of plants intended for replanting of: leek, beet, cabbage, strawberries, asparagus, shallot, onion, dahlia, gladiolus, hyacinth, iris, lily, narcissus, tulip;
- can be released only after that is has been officially established **the absence of PCN by analysis**.

# PHYTOSANITARY MEASURES TO THE FARMS AND WAREHOUSES

The **contaminated tubers** stored in the farm warehouse, under the approval of Plant Protection Service:

- **must be preserved in a well identified place and separated from tubers of other origins;**
- **must not be used as seed;**
- **can be transferred, but the transactions must be properly documented and the records must be kept on the farm;**
- **may be addressed to the fresh market or to industrial processing, through direct and immediate delivery to a factory that get procedures for waste disposal;**
- **in case of direct sales, the soil adhering to the tubers must be completely removed and the waste disposed.**

The **warehouse place** must be washed with **steam at 100 °C** by means of a pressure washer and the washing water conveyed to the sewer.



# PROCEDURES FOR THE OFFICIAL BODY

- Sample all the plots intended for potato seed before planting
- Sample 0.5% of the total surface cultivated with ware potatoes even during the crop growing
- Provide the farmers and the warehouses for the phytosanitary measures in case of finding of living cysts, checking the compliance with them
- Establish an official program of PCN control and verify the success over time
- Verify the effectiveness of potato varieties, resistant to the local pathotype of *Globodera*
- Keep an official register to be transmitted each year to the National Phytosanitary Service and the European Union

# OFFICIAL PROGRAM FOR PCN CONTROL

The infested plots intended for growing of ware and industry potatoes are subject to an official program for the PCN control

The main method of PCN control is agronomic, with rotations at least three years and growing:

- resistant varieties
- Non host species (cereals, legumes, brassicas)
- Green manure intercrops (horseradish, mustard or rocket) cultivated for about 60 days, then chopped and incorporated to the soil, with effect of catch crop and biofumigation.

The official program must be established by SFR in agreement with the farmers, communicated to National Phytosanitary Service and inspected in time by site visit and soil sampling to verify the decrease of the PCN population.

**THANK YOU FOR YOUR  
ATTENTION !**

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