Towards Safer Seeds:
The Changing Landscape of Seed Health Testing

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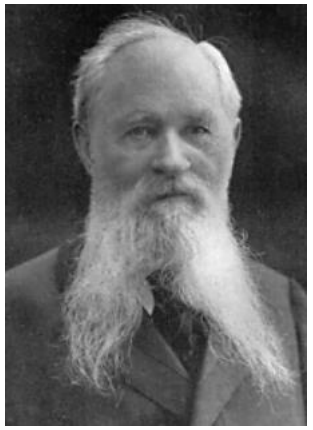
On the origin of seed health testing – *key milestones*



Friedrich Nobbe – 1869
1st Seed Testing Station (GER)
Germination & purity

Lucie Doyer – 1910s/1940s
1st Seed Health Testing Lab (NL)
fungal seed-borne diseases &
blotter method

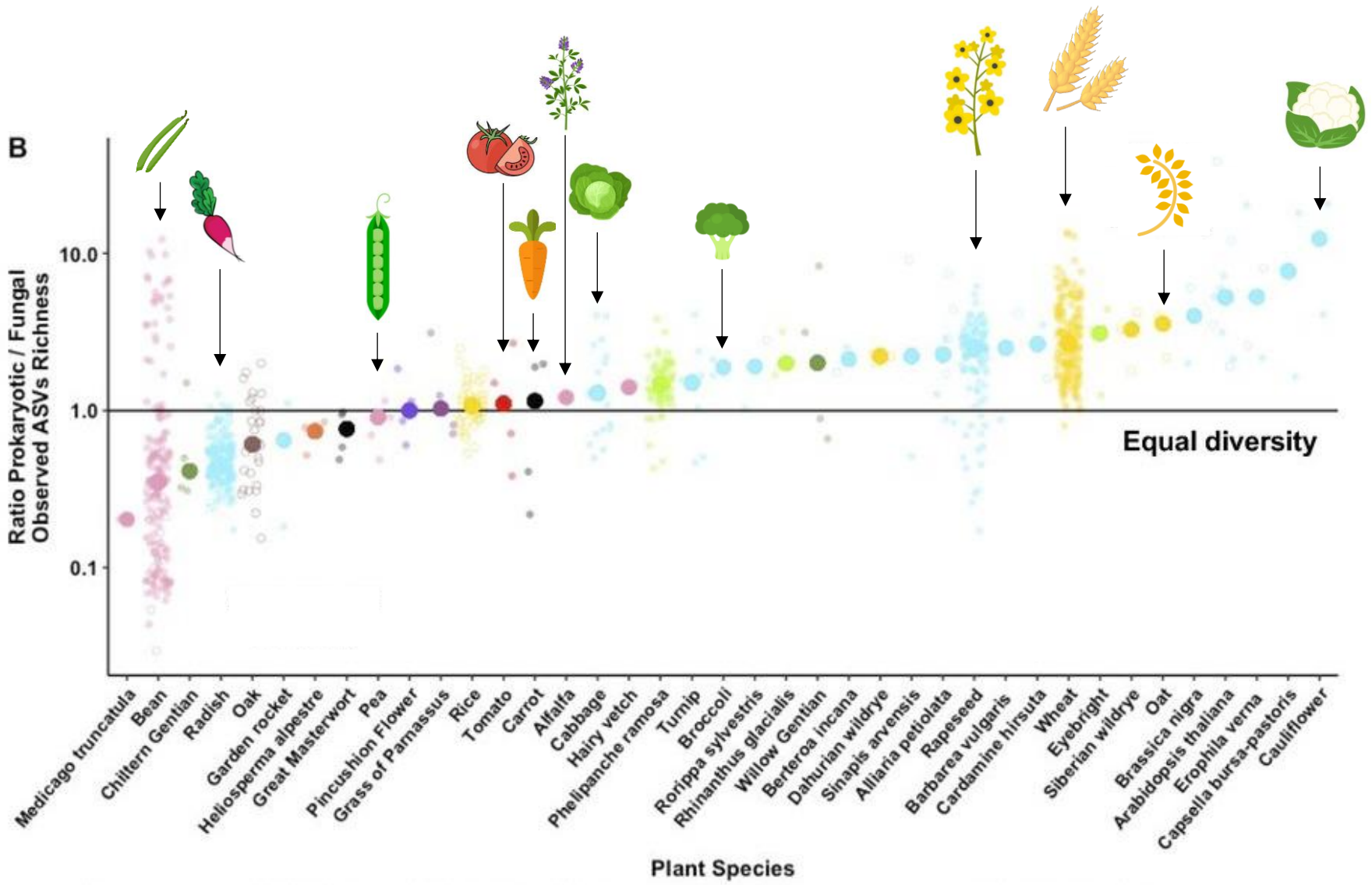
Attendees - 1st Seed Pathology Workshop
Seed Testing Station, Cambridge, UK, 1958.

Mary Noble & **Paul Neergaard** - 1950s
Coin the term "seed pathology"

+ **Johannes de Tempe**
"An annotated list of seed-borne diseases"

Nobbe, In: Handbuch der Samenkunde (1876); Noble, Nature (1951); Noble, In: Biological Aspects of the transmission of diseases (1957); Baker & Smith, Annu. Rev. Phytopathol. (1966); Neergaard, In: Seed Pathology (1977); Neergaard, Annu. Rev. Phytopathol. (1986); Agarwal & Sinclair, In: Principles of seed pathology (1997); McGee, Plant Dis. (1981); McGee, Annu. Rev. Phytopathol. (1995); Maud, In: Seedborne diseases and their control (1996); Gitaitis and Walcott, Annu. Rev. Phytopathol. (2007); Munkvold, Annu. Rev. Phytopathol. (2009); Goswami et al., In: Seed-Borne Diseases of Agricultural Crops (2020); Kumar & Gupta, In: Seed-Borne Diseases of Agricultural Crops (2020); Srivastava et al., In: Seed-Borne Diseases of Agricultural Crops (2020); Got, In: Histoire des essais de semences dans une perspective transnationale (2024); Munkvold et al., Annu. Rev. Phytopathol. (2025)

Seed-associated microbial diversity



procaryotes > fungi

fungi > procaryotes

Simonin et al., New Phytol. (2022)

Why being concerned about seed-borne pests?

From science…

- Colonization of seeds by large numbers of microorganisms

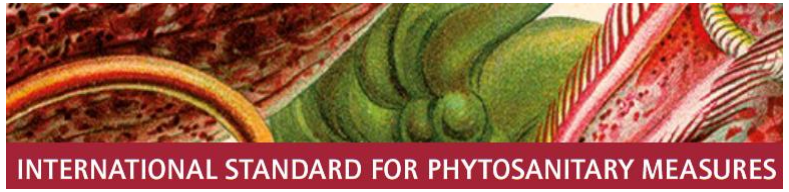
- Some of them = transmitted via seeds
- If pathogenic = diseases / epidemics / outbreaks

… to R&D (public & private)
… to R/N PPOs & policymakers

- Detection, treatment, breeding…
- Pest Risk Analysis

High-quality seeds for healthier plants and people

Pest risk analysis – *seed pests*

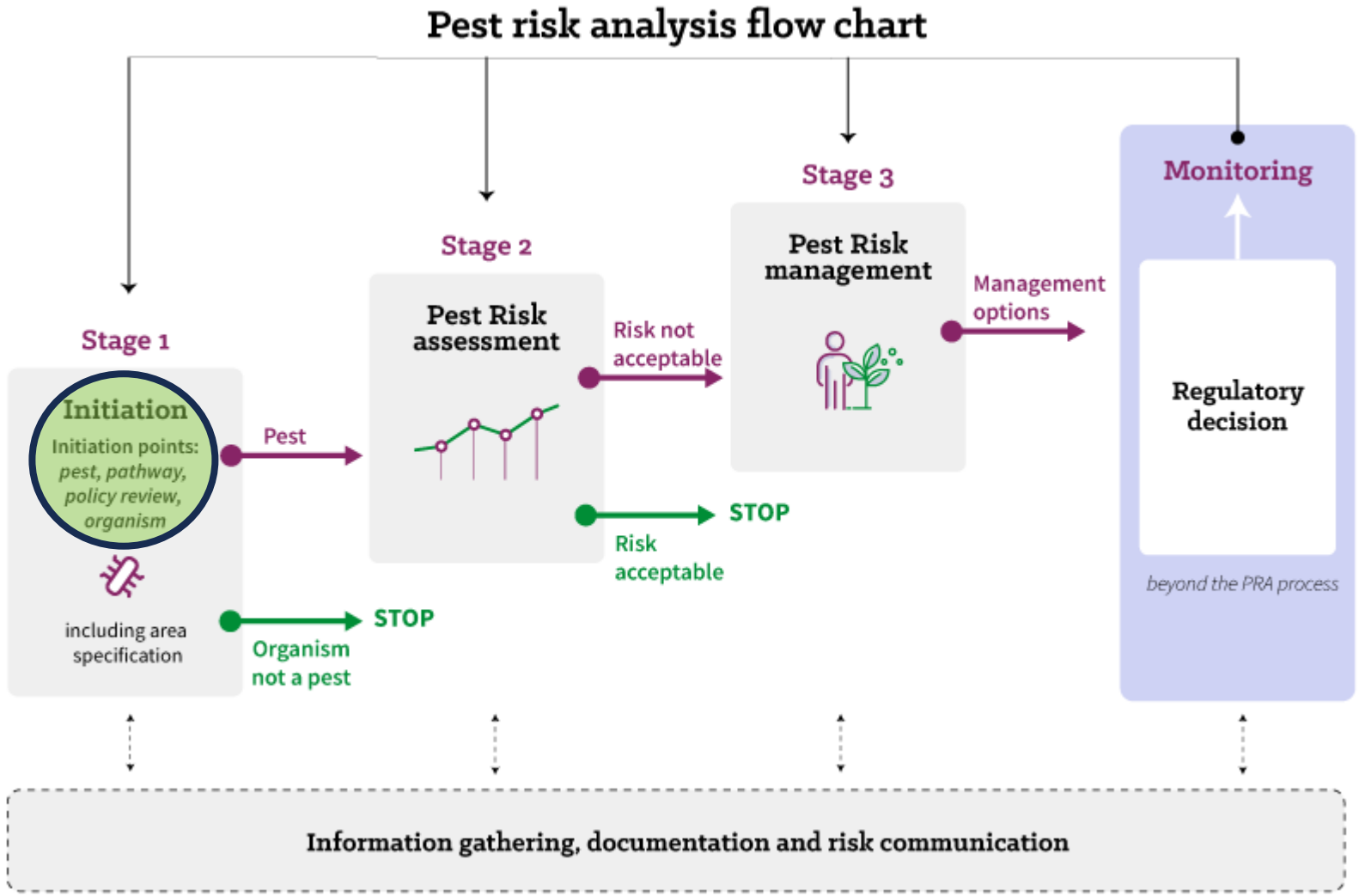


Food and Agriculture Organization of the United Nations

International Plant Protection Convention

ISF Regulated Pest List Initiative

Reference Pest List

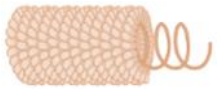


IPPC Secretariat, in: ISPM02 (2007)

Terminology

"pests"


fungi


viruses / viroids


bacteria

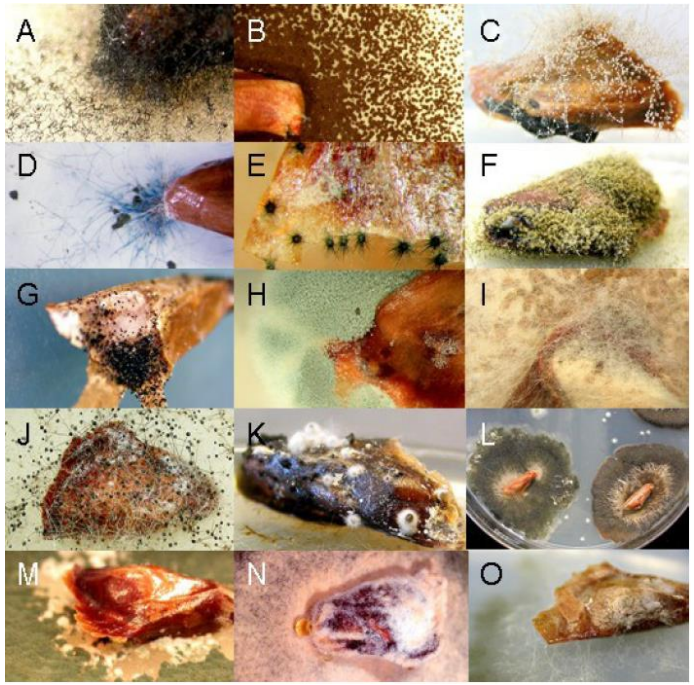

oomycetes


nematodes


insects

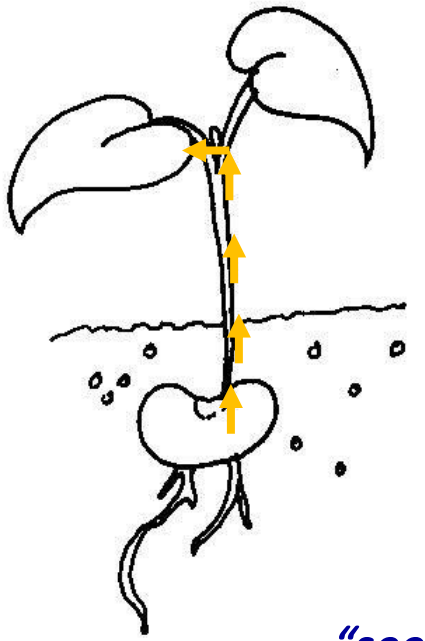
"seed-borne"

(carried internally / externally)



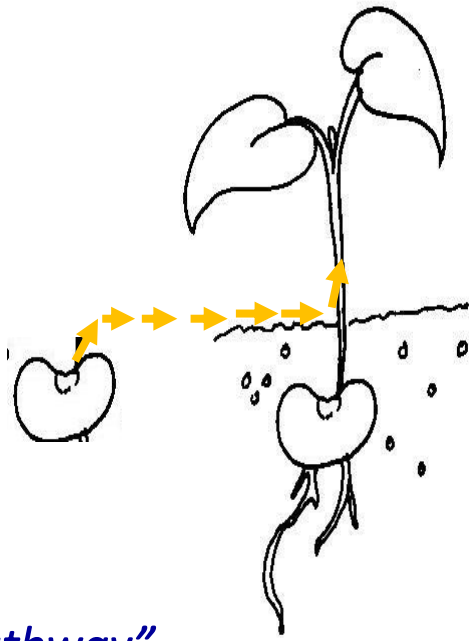
"seed-transmitted"

(seed >> plant)



"seed-transferred"

(seed >> soil >> plant)



"seed pathway"

(successful transmission/transfer)

IPPC Secretariat, in: ISPM05 (2015); IPPC Secretariat, in: ISPM38 (2017); Talgø et al., Seed Sci. Technol. (2010)

Inventory of seed-borne pests

1958 - 1990

Noble et al., 1st edition (1958);
Noble & Richardson, 2nd edition (1968);
Richardson, 3rd edition (1979);
Richardson, Supplement 1 (1981);
Richardson, Supplement 2 (1983);
Richardson, 4th edition (1990)

International experts

(independent review)

(public / private sectors; governmental bodies)

> 2018

Home / Tools / Seed Health Committee

ISTA Reference Pest List

2025 01 27 ISTA Reference Pest List v14 (XLS,823.0 kB)

Pest: ***seed-borne*** and ***seed-transmitted*** by seeds ?
Pest: ***seed-borne*** and ***transferred*** by seeds ?

no	uncertainty	yes
Seed ≠ pathway	Pathway **not proven**	Seed = pathway
	No research found No definitive evidence Contradictory results Or Artificial proof only	

Denancé & Grimault, EPPO Bul. (2022)
Denancé & Malabarba, Seed Testing International (2025)

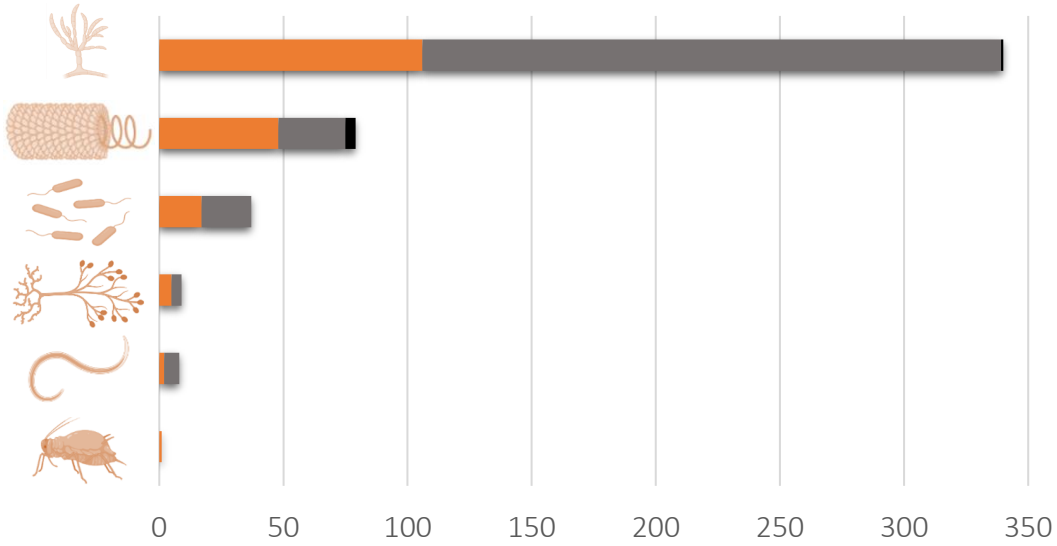
ISTA Reference Pest List – *current status (v15; Jan. 2026)*

45 hosts

511 seed-borne pests

180 “seed pathway”

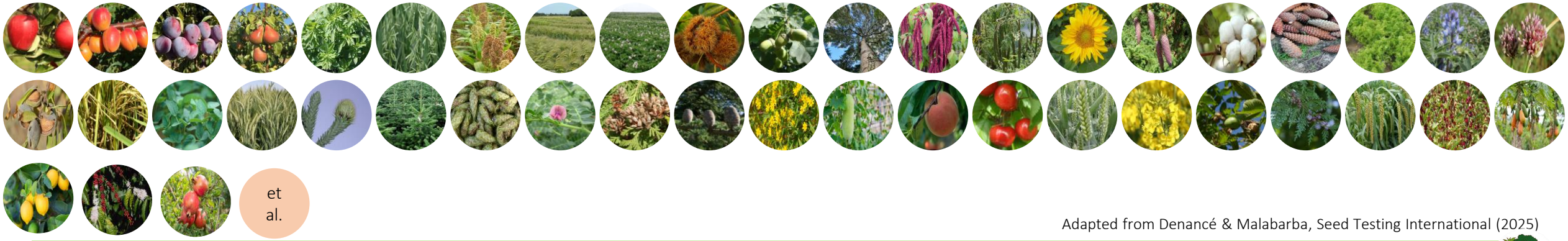
755 articles



Seed = pathway

Pathway Not proven

seed ≠ pathway

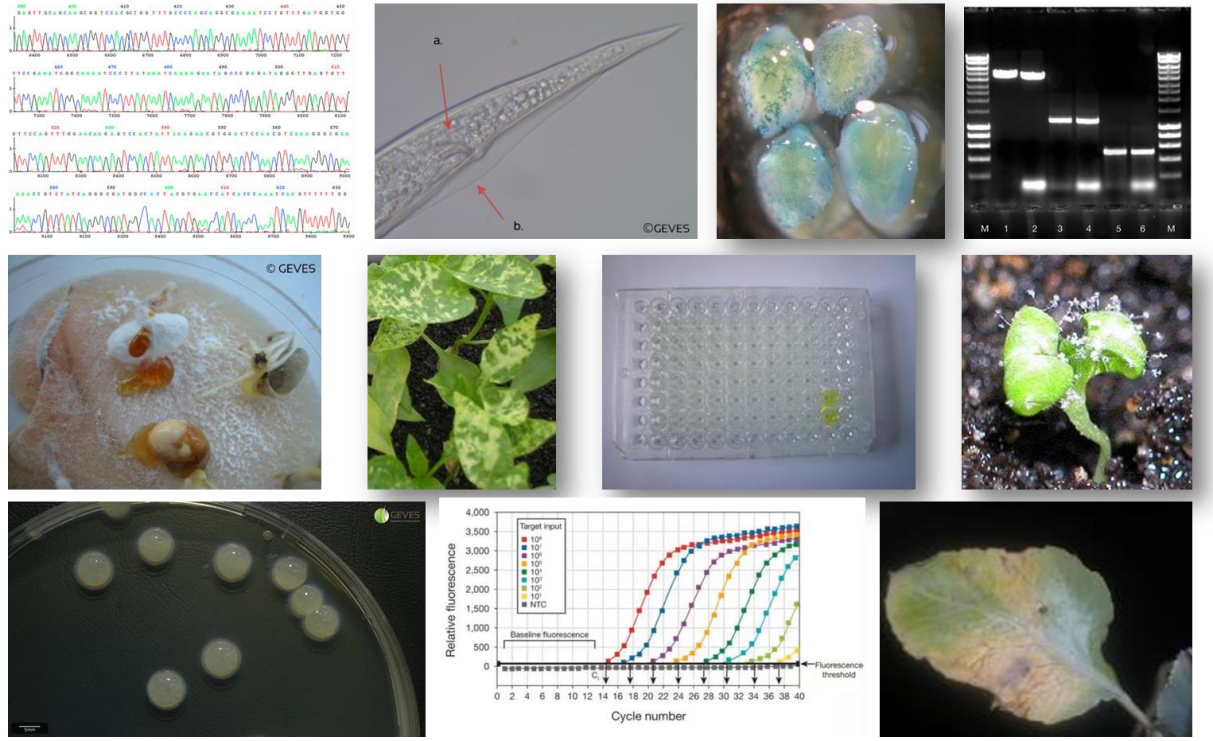


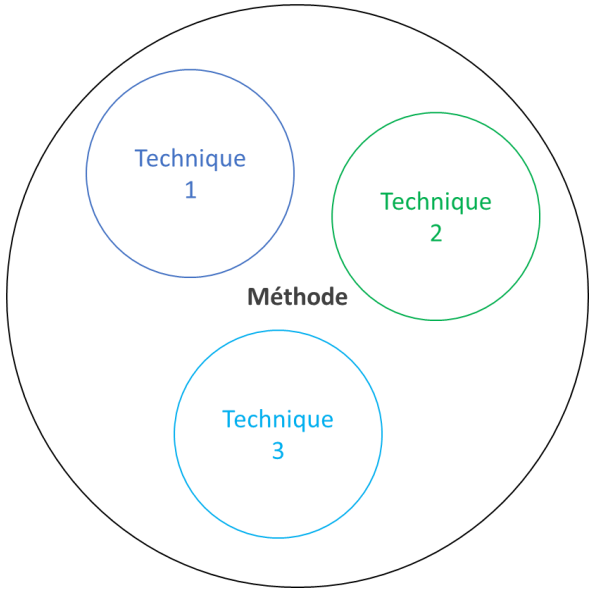
et al.

Adapted from Denancé & Malabarba, Seed Testing International (2025)

Seed Health methods

- Direct : detection of the pest itself
- Indirect : detection of parts of the pest





	pres/abs	Viab.	Pathog.
Isolation on culture medium	✓	✓	✗
Seed washing, Embryo extraction	✓	✓	✗
Grow-out, Bioassay, Pathogenicity	✓	✓	✓
ELISA, Molecular biology / Sequencing, Imaging	✓	✗	✗

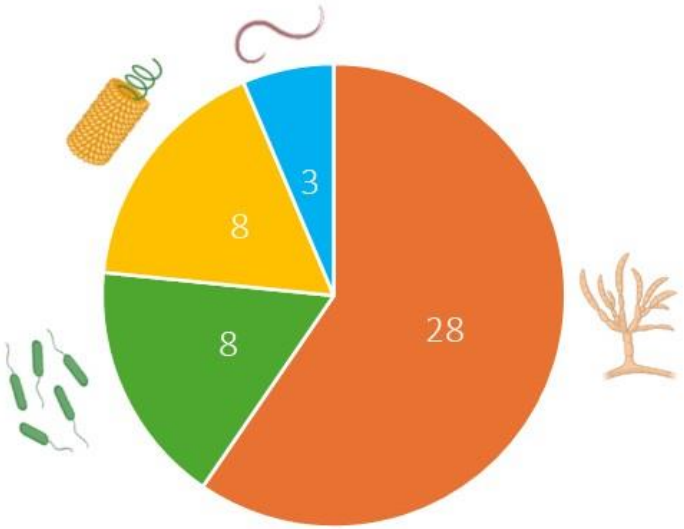
Adapted from Denancé & Sérandat, Phytoma (2023)

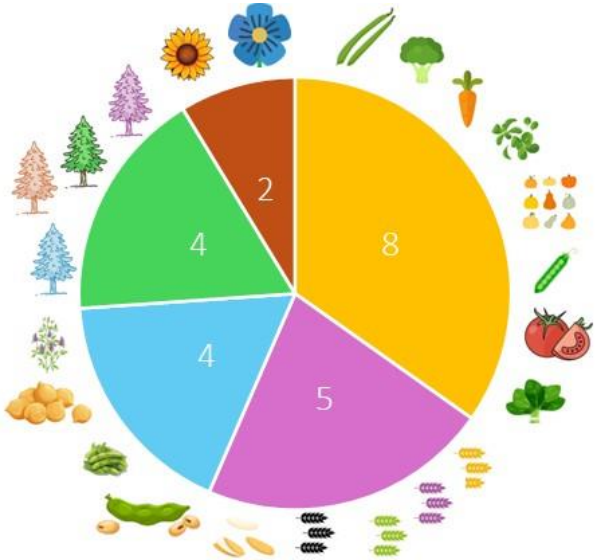
ISTA Seed Health Methods – *current status*

- 36 official international methods
- 9 developed at GEVES
- 30 validated only on non-treated seeds

- Microbiology
- Morphobiometry
- Molecular biology
- Plant assays
- Serology

- Fungi (mostly)
- Bacteria / viruses
- Nematodes





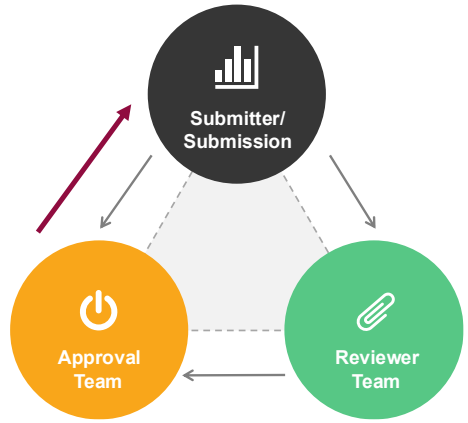
- Vegetables (mostly)
- Cereals
- Legumes
- Fruit/forest species
- Oilseed crops

Denancé & Malabarba, Seed Testing International (2025)

Training to recognize pests

Seed Health Test Image Database

- Image database of seed pests and plant symptoms
- Priority: pests with existing ISTA SH methods
- Long-term goal: pests cited in ISTA Reference Pest List
- with metadata (growing conditions, etc.)



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Submission

Alternaria linicola on Linus usitassimum

Credits / Owner: Angela Thüringer, AGES

Submission date: 2024-06-20 12:08:52

Submission ID: #37

Submission

Description

Alternaria linicola forms small and circular olivegreen to grey colonies. The bottom of the colonies appear dark.

Growth time:	9 days
Lighting:	darkness
Agar:	PDA
Agar brand:	Merck
Sample origin:	Sweden

Pathogen

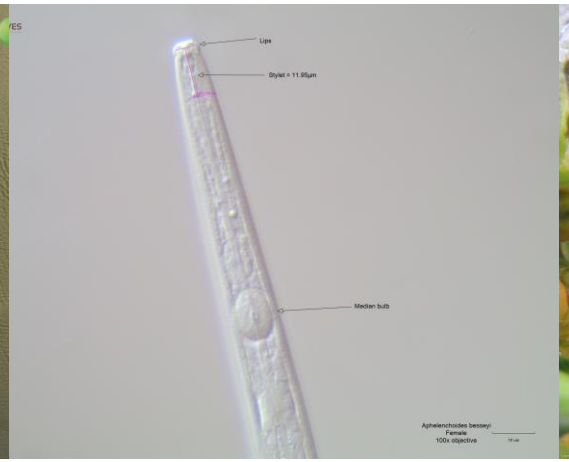
Scientific name	Alternaria linicola
Genus	Alternaria
EPPO code	ALTELI
Common name	Seedling blight
Synonyms	
Crop	Linus usitassimum

More about Alternaria linicola

Cailliou, Seed Testing International (2024); Denancé & Malabarba, Seed Testing International (2025)

ISTA SH Image DB – *current status*

- 80 pests illustrated
- +450 photos


Fungi
(53 species)

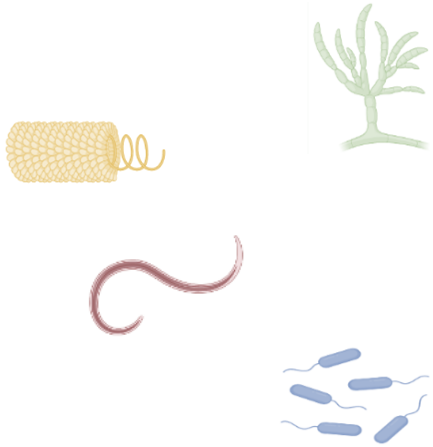
Bacteria
(23 species)

Nematodes
(4 species)

Symptoms
(4 diseases)

Take home messages

- Seeds = microbial diversity
- ISTA Seed Health tools tryptic:
  - knowledge : inventory (ISTA Reference Pest List)
  - Detection : methods (ISTA Seed Health methods)
  - Training : images (ISTA Seed Health Tests Image Database)
- Supporting the seed sector
- Providing farmers with higher-quality seeds



Thank you !

Scan me!

GEVES
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Station Nationale d'Essais de Semences

Jaiana Malabarba
Eduardo Galvez Sotelo
All the staff !
Caroline Bellenot
Giulia Farinaro

ISTA
Seed Quality Assurance

Seed Health Committee
Executive Committee
Secretariat

oepp eppo

Muriel Suffert
All the staff!
(GD, PRA platform…)