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Prof. Dr. Joseph-Alexander Verreet, Dr. Holger Klink (eds.)

## DISEASES AND PESTS OF SUGARBEET

2

In-depth understanding of the conditions under which pathogens live and develop is a prerequisite for effective crop protection. The series "Diseases and Pests of Sugarbeet" grants easy access to this knowledge. Through an exciting blend of vivid animations and real images, with informative commentaries, these videos provide a fascinating insight into the life cycles of major pathogens. The series is an outstanding example of communication in modern science.

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### MULTILINGUAL DVD:

English, Chinese, Croatian,  
Czech, Danish\*, Dutch,  
French, German, Hungarian,  
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\* available only for "Rhizomania"

### Target groups:

Students, farmers, technical  
advisors, teachers

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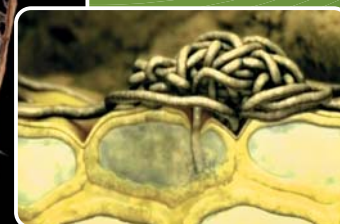
MULTILINGUAL DVD



2.1 Rhizomania



2.2 Root Rot –  
Biologic Strategies of  
Root-Rotting Pathogens



Plant pathology is a discipline devoted to maintaining plant health and, by so doing, helping to ensure economically and ecologically sound production of foodstuffs in sufficient quantities and of high quality. This places great demands on the effectiveness of research. It also presupposes in-depth knowledge of many aspects of both abiotic and biotic pathogens (e.g. fungi, bacteria, viruses, animal pests) and of plant protection.

Teaching is therefore of great importance. One especially interesting aspect of it is the transfer of knowledge of the sometimes very complex biological relationships in the life or development cycles of pathogenic organisms – host-parasite relationships which run their course under prevailing plant cultivation and environmental conditions. The video series “Diseases and Pests of Sugarbeet” employs state-of-the-art visualization methods to illustrate the life cycles of various pathogens. The combination of vivid 3D computer animations with real images results in a realistic overall picture that helps the viewer to understand the bio-ecological aspects of host-parasite relationships. This new information medium addresses both specialist and lay audiences. The target groups include teachers and students at many types of educational institutions, university lecturers, students of agronomy, biology, ecology and their related disciplines, as well as governmental and non-governmental advisory bodies and, last but not least, farmers.

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Joseph-Alexander Verreet

Holger Klink

DVD Series “Diseases and Pests of Sugarbeet” (Vol. 2)

### 2.1 Rhizomania (12:00 min)

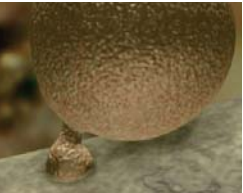
Rhizomania or “root madness” is one of the most serious diseases of sugarbeet. It is caused by *Beet necrotic yellow vein virus* (BNYVV). The virus is carried and transmitted by the soilborne protozoan *Polymyxa betae*. When zoospores of *P. betae* carrying BNYVV invade roots of sugarbeet, the virus is released by the protozoan, multiplies, and spreads within the plant. Virus infection causes massive proliferation of secondary roots, giving the taproot a bearded appearance. Storage of sugar in the taproot is substantially reduced. With photo-like 3D computer animations, the film illustrates the life cycle of the virus vector *P. betae*, thus leading to a better understanding of the development of rhizomania and, consequently, means of controlling it. Finally, information on new high-yield rhizomania-resistant varieties of sugarbeet is presented.

### 2.2 Root Rot – Biologic Strategies of Root-Rotting Pathogens (9:50 min)

Soilborne pathogens known to cause root rot of sugarbeet include *Rhizoctonia solani*, *Fusarium oxysporum* and *Aphanomyces cochlioides*. In order to utilize the energy stored in the sugarbeets, these pathogens adopt different strategies: *Rhizoctonia solani* forms specialized infection structures (infection cushions), *Fusarium oxysporum* releases toxins that support fungal growth within the beet's vascular system, and the mode of infection of *Aphanomyces cochlioides* is characterized by formation of motile zoospores. The various biologic strategies are illustrated in detail, followed by sequences focusing on agronomic disease management methods, including plant resistance.

## Glossary\*

**Actinomycetes:** a group of filamentous microorganisms similar to bacteria.



Adherosium

**Adherosium**, pl. **adherosia:** the organ developed from a resting zoospore for attachment and penetration.

**Aphanomyces cochlioides:** an oomycetous pathogen that causes root rot of sugarbeet.

**Appressorium**, pl. **appressoria:** swollen, flattened portion of a fungal filament that adheres to the surface of a host plant,

providing anchorage for invasion by a fungus.

**Assimilate:** photosynthetic product of plants (mainly sugars, amino acids) produced in green plant parts and used to form plant biomass; basic source of nutrition for many parasitic fungi.

**Bacterium**, pl. **bacteria:** a prokaryotic, microscopic, single-celled organism with a cell wall that increases by binary fission (a type of asexual reproduction in which two cells, usually of similar size and shape, are formed by the growth and division of one cell).

**Beet necrotic yellow vein virus:** viral pathogen that causes rhizomania of sugarbeet.

**Cell membrane**, syn. **plasma membrane:** structure that surrounds a cell and helps control the movement of substances into and out of the cell.

**Cell wall:** protective, permeable structure external to the cell membrane in plants, bacteria, fungi, and certain other organisms.

**Conidiophore:** simple or branched hypha on which conidia are produced.

**Conidium**, pl. **conidia:** asexually formed non-motile fungal spore transported by wind or water; immediately capable of germination.

**Cortex**, adj. **cortical:** region of parenchyma tissue between the epidermis and the vascular system in stems and roots.

\* Many of the definitions listed are based on the *Illustrated Glossary of Plant Pathology*, APS Education Center (Authors: C. J. D'Arcy, D. M. Eastburn, and G. L. Schumann)

**Crop rotation:** organization of the chronological sequence of crops on one land area. Growing the same crop too frequently on the same land (i.e. monoculture) can lead to an accumulation of pathogens adapted to this crop in the soil and in plant residues, which consequently can lead to massive infection. In order to avoid this accumulation, rotation of dissimilar crop plants is practiced.

**Crown:** in beets, junction of root and foliage, usually at the soil line.

**Cultivar**, syn. **variety:** a plant type within a species, resulting from deliberate manipulation, which has recognizable characteristics.

**Cyst:** in fungi, a resting structure in a protective shell-like enclosure; in oomycetes, the cell-wall bound structure formed after zoospores lose motility; in nematodes, the egg-laden carcass of a female nematode.

**Cystosorus**, pl. **cystosori:** a cluster of thick-walled resting spores.



Cystosorus

**Cytoplasm:** the liquid substance that fills the space between the cell and vacuolar membranes excluding the nucleus of a cell.

**Diagnosis:** identification of the cause of a disease based on symptoms, pathogen-specific structures, and results of laboratory tests.

**Disease cycle:** succession of all the events and interactions among the host, pathogen and environment that occur in a disease, from initial infection of the host by a causal agent, through pathogenesis, to over-seasoning, until another infection occurs.

**Dormancy**, adj. **dormant:** a condition of suspended growth and reduced metabolism of an organism, generally induced by internal factors or environmental conditions as a mechanism of survival.

**Endoparasite:** parasitic organism that lives and feeds from inside its host.

**Enzyme:** protein that catalyzes a specific biochemical reaction, e. g., in the course of infection, certain pathogens (fungi, oomycetes, bacteria) produce enzymes that dissolve or break down cell walls (e.g. cutinases, cellulases, pectinases) and facilitate the penetration of host tissues.

**Epidermis**, adj. **epidermal**: surface layer of cells.

**Flagellum**, pl. **flagella**: hairlike, whiplike, or tinsel-like appendage of a motile cell, zoospore or bacterium that provides locomotion.

**Fungi (Eumycota)**: chlorophyll-free organisms that cannot grow without organic substances, in particular carbohydrates, from other organisms. Fungi may possess one or several cell nuclei. The main constituent of the cell wall is chitin.

**Fusarium oxysporum**: a soilborne deuteromycete pathogen that colonizes the vascular system of sugarbeets and results in wilting, yellowing, and necrosis of foliage.

**Germinate**, n. **germination**: begin growth (as of a seed, spore, stroma, or other reproductive body).

**Germ tube**, syn. **germination hypha**: hypha resulting from an outgrowth of the spore wall and cytoplasm after germination; usually secretes mucilaginous substances which promote close contact with the plant surface.

**Heterotroph**: an organism that obtains nourishment from outside sources and must obtain its carbon from organic carbon compounds.

**Host**: living plant attacked by or harboring a parasite or pathogen.

**Hypha**, pl. **hyphae**: threadlike organs of fungi and oomycetes that spread through plant tissue; the totality of the hyphae = the mycelium.

**Infection**: entering, invasion, or penetration of a host (plant)

by a pathogen in order to establish a parasitic relationship.

**Infection cushion**: organized mass of hyphae formed on the surface of a plant from which infective hyphae develop.

**Infest**, n. **infestation**: to attack as a pest (used especially with nematodes and insects); to contaminate, as with microorganisms; to be present in large numbers.

**Intercellular**: between or among cells.

**Intracellular**: through or within cells.

**Lesion**: localized diseased area or wound.

**Life cycle**: cyclical succession of stages in the development of an organism.

**Middle lamella**: the layer, consisting largely of pectic substances, between the walls of adjacent plant cells.

**Mycelium**, pl. **mycelia**: mass of hyphae constituting the body (thallus) of a fungus.

**Necrosis**, adj. **necrotic**: death of cells or tissue, usually accompanied by black or brown darkening.

**Oomycetes**: class of fungal-like organisms typically with nonseptate mycelium, asexual sporangia and zoospores, and sexual oospores.

**Parasite**, adj. **parasitic**: organism that lives in intimate association with another organism on which it depends for its nutrition; not necessarily a pathogen.

**Pathogen**, adj. **pathogenic**: organism (e.g. bacterium, virus, fungus, oomycete, nematode) that can cause disease in another organism.

**Pathogenesis**: the incitement, development and results of disease.

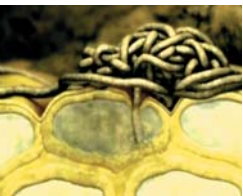
**Penetration**: initial invasion of a host by a pathogen.

**Pest**: any organism that damages plants or plant products.

**Photosynthesis**: the basic process in the formation of organic matter by photosynthetic organisms in which atmospheric CO<sub>2</sub> is fixed via light energy to produce simple sugars.

**Plasma membrane**, syn. **cell membrane**: structure that bounds a cell and helps control the movement of substances into and out of the cell.

**Plasmodium**, pl. **plasmodia**: multinucleate mass of protoplasm moving and feeding in amoeboid fashion.



Infection cushion

***Polymyxa betae***: a soilborne protozoan serving as a vector of *Beet necrotic yellow vein virus* (BNYVV) by carrying the virus to healthy roots; BNYVV is the causal agent of rhizomania, one of the most serious diseases of sugarbeet.

**Protozoan**: a unicellular eukaryotic organism that lives as single cells or in simple colonies.

**Resistance**, adj. **resistant**: a) plant: genetically determined protection against diseases; b) fungus: genetically determined protection against fungicides/host metabolites.

**Resting spore**: spore, often thick-walled, that can remain alive in a dormant state for some time, later germinating and capable of initiating infection.

***Rhizoctonia solani***: a soilborne fungal pathogen causing diseases of numerous host plants, e.g., root and crown rot of sugarbeet.



**Rhizomania**: “root madness”, a disease of sugarbeet caused by *Beet necrotic yellow vein virus* (BNYVV); the soilborne protozoan *Polymyxa betae* is the vector of BNYVV.

**Root hair**: threadlike, single-celled outgrowths from a root epidermal cell.

**Rot**: softening, discoloration, and often disintegration of plant tissue as a result of fungal or bacterial infection.

**Saprophyte**, adj. **saprophytic**, syn. **saprobe**: organism that obtains nourishment from non-living organic matter.

**Secondary root**: branch from a primary root.

**Septum**, pl. **septa**, adj. **septate**: dividing wall; in fungi, cross wall.

**Species**: any one kind of life subordinate to a genus but above a race; a group of closely related individuals of the same ancestry, resembling one another in certain inherited characteristics of structure and behavior and relative stability in nature; the individuals of a species ordinarily interbreed freely and maintain themselves and their characteristics in nature.

**Spore**: mono- or multicellular reproductive structure of fungi; it serves for reproduction or proliferation of the species or as a dormant stage (thick-walled resting spores) for surviving unfavorable environmental conditions.

**Sporulation**: the process of producing spores.

**Stunting**, syn. **stunted growth**: reduction in height of the vertical axis of a plant.

**Susceptible**, n. **susceptibility**: prone to develop disease when infected by a pathogen.

**Symptom**: indication of disease by reaction of the host, e.g., leaf spot or wilt.

**Taproot**: primary root that grows vertically downward and from which smaller lateral roots branch.

**Tolerance**, adj. **tolerant**: ability of a plant to endure an infectious or non-infectious disease, adverse conditions, or chemical injury without serious damage or yield loss.

**Toxicity**: capacity of a substance to interfere with the vital processes of an organism.

**Toxin**: poisonous substance of biological origin.

**Variety**, syn. **cultivar**: a plant type within a species, resulting from deliberate manipulation, which has recognizable characteristics.

**Vascular**: pertaining to the fluid-conducting tissues (xylem and phloem) in plants.

**Vector**: a living organism able to carry and transmit a pathogen and disseminate disease.

**Vein**: small vascular bundle in a leaf.

**Vessel**: water-conducting structure.

**Virus**, adj. **viral**: a submicroscopic, intracellular, obligate parasite consisting of a core of infectious nucleic acid (either RNA or DNA) usually surrounded by a protein coat.

Root hairs

**Virus vector:** a living organism able to carry and transmit a virus.

**Wilt:** drooping of leaves and stems from lack of water (inadequate water supply or excessive transpiration); vascular disease that interrupts normal water uptake.

**Yellows:** disease characterized by chlorosis (yellow discoloration) of plant tissue due to low chlorophyll content. Chlorosis may be due to non-living (abiotic) causes (e.g., deficiency of iron, calcium or other nutrients) or living (biotic) causes (pathogens). Chlorosis usually precedes necrosis.

**Yield:** an aggregate of the products resulting from growth or cultivation.



Zoospores emerging from a zoosporangium

**Zoospore:** spore with flagella, capable of locomotion in water.

**Zoosporangium, pl. zoosporangia:** sporangium, or spore case, that bears zoospores.