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SOIL BORNE DISEASES: PRACTICAL INFORMATION

This factsheet contains complementary information to the Best4Soil video on Soil borne diseases: practical information.

Soil borne diseases are caused by soil borne pathogens, a group of microorganisms that can cause the reduction or limitation of yield in intolerant crops. Soil borne pathogens include nematodes, fungi, bacteria and even viruses.

Once soil borne pathogens are present in a soil, they can be controlled by chemical soil fumigation. However, fumigation is expensive (it is not economically feasible for extensive or open field crops) and non-selective (the majority of the living organisms within the soil, including beneficial and saprophytic[1] microorganisms are also reduced after fumigation). Avoiding outbreaks of soil borne diseases can be achieved if a soil health strategy is adopted (Link to Factsheets EIP AGRI: https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_infographic_soil_health_2015.pdf). Soil health is maintained or increased by means of the 4 Best Practices of Best4Soil.

NEMATODES AND FUNGI

These two groups of organisms include the majority of the soil borne pathogens that are economically relevant. In Best4Soil database (LINK) you can find information on the nematodes and soil borne fungal pathogens of the main field crops, vegetables and green manure crops grown in Europe.

Nematodes are small worms, mostly microscopic in size, which are impacted by soil temperature and moisture content. Therefore, there are some species more adapted to the environmental conditions of Southern Europe and others to Northern Europe conditions. Nematodes prefer sandy soils but some species are also common in clay soils. It is crucial to understand their life cycle. Some species have specific root-infective motile stages, and adult females that are non-motile (fig. 1).

[1] Saprophytic organisms are involved in the degradation of dead organic matter in soil.

Fig. 1: Non motile females of a cyst nematode (*Heterodera schachtii*) breaking out of cabbage roots.

Fungal infections also depend on the soil temperature and moisture content. Oomycetes and Chitridia[2] are microorganisms that produce flagellate spores. These are spores able to swim in with water-filled pores of the soil, thus moving from diseased to no diseased roots, spreading the disease very efficiently. Moreover, most fungal pathogens produce quite resistant resting spores, which allow them to survive for longer periods in the soil. Such resting structures include chlamydospores, oospores, microsclerotia or sclerotia (fig. 2). There are reports of microsclerotia or cyst spores surviving in soils for more than 10 years.

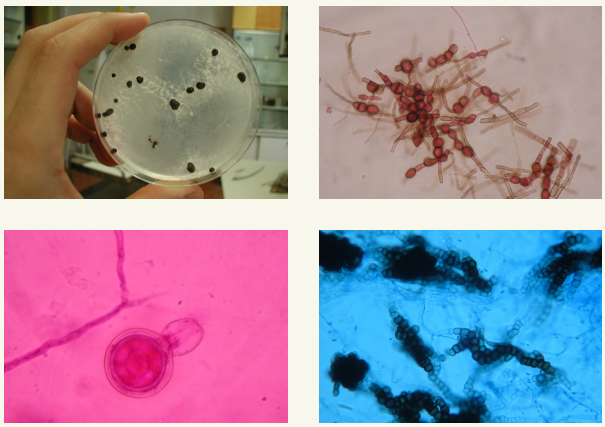

Fig. 2: Examples of resting structures of fungi (from top to bottom and left to right): Sclerotia; Chlamydospores; Oospores; Microsclerotia.

[2] Oomycetes and Chytridia were historically identified as fungi, however they are actually no more included in the Kingdom Fungi.

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Both nematodes and fungi can survive in soils by means of resting structures or bodies fixed to the detached roots after removal of an infested crop. This is a reason for planning precise crop rotations, to avoid the perpetuation of soil borne pathogens in a soil. You can learn about crop rotation in Best4Soil Video 12 (https://best-4soil.eu/videos/12). There are other practices that will help you to increase soil health, thus reducing the presence of soil borne pathogens and increasing the presence of beneficial organisms and increasing the fertility of your soil. These practices are covered by Best4Soil videos and factsheets. Visit our webpage for more information www.best4soil.eu

SYMPTOMS AND DIAGNOSIS

As soil borne pathogens are microscopic and inhabit the soil, their detection is difficult until symptomatic plants appear. Symptoms of soil borne diseases (also called telluric or edaphic diseases) may resemble other biotic or abiotic stresses, but the general appearance of affected plants is similar. They display symptoms such as wilt, chlorosis (yellowing of the leaves), dry leaves, epinasty, or plant decay. These visible symptoms of the above ground plant structures correspond to the damage caused by soil borne pathogens. They can be divided into 2 types: Damage of the roots and / or stem base and damage of the vascular system. Examples of the first type of damage are found for fungal pathogens such as *Pythium aphanidermatum* or *Colletotrichum coccodes* (fig. 3 and 4), but also for nematodes (fig. 5).

Fig. 3: Symptoms of cucumber stem rot caused by *Pythium aphanidermatum*.

Fig. 4: Symptoms of root rot caused by *Colletorichum coccodes* Early stage (top) and late stage (bottom) on tomato root infection.

Fig. 5: Bad growing patches in onions caused by *Meloidogyne fallax*. Knots formed by the nematode visible on the roots.

Damage such as this is caused by an infection of the roots by the pathogen, which destroys the roots and/or the crown of the plant so that it is unable to absorb or transport water and nutrients. Vascular diseases imply the colonization of the xylem of plants by a fungus, which clog the plant vessels, reduce the water pressure in the leaves and release toxins into the plant (fig. 6).

Fig. 6: Tomato xylem vessels showing necrosis caused by *Verticillium dahliae*.

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Wilting appears initially on the youngest leaves, and generally in the warmest hours of the day. As the development of the disease progresses, wilt is more evident throughout the day, sometimes even killing the plant completely (fig. 7). Chlorosis, necrosis or simply epinasties (green wilt with decay of plant organs) can appear before a general wilt symptom appears (fig. 8).

Fig. 7: Wilt prior to death of tomato plant.

Fig. 8: Epinasty in cucumber plant.

These symptoms can be easily confused with a lack of water, and can lead to more abundant and frequent irrigation, which itself can increase the rate and spread of infection in the case of a soil borne disease. Plants infected by soil borne pathogens appear in spots or within the crop rows, homogeneous and generalized affections covering an entire field are normally not observed at the beginning of disease development.

Diagnosis of the causal agent of the disease is essential, as different pathogens or other environmental reasons can produce similar symptoms. Some of the microscopical structures above mentioned can help to identify the pathogen, but specialised laboratories are required for a reliable diagnosis. The control of each pathogen will require a different solution, and the knowledge of the relationship hosts x pathogen is crucial for a successful control. Best4Soil provides knowledge on hostplant x pathogen or nematode relationship by the means of two databases (link to scheme).

BENEFICIAL AND SAPROPHYTIC ORGANISMS

It should be remembered that not only harmful microbes live in the soil, 99% of the microorganisms living in an agricultural soil are not pathogenic. The majority are saprophytic, which means that they are involved in the decomposition and mineralisation of dead organic matter, which is essential for maintaining soil fertility. Insects and mites initiate organic matter trituration, earthworms continue transforming the organic matter into humus, later nematodes refine the product, followed by fungi, which participate in the aggregation of organic matter, and finally bacteria proceed with the mineralisation and oxidation or reduction of minerals, making them available for the plant roots.

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