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Taifun Soy Info

Specialist information for soybean producers and processors

Diaporthe/Phomopsis - most important fungal disease on soybeans

1. Overview

An entire fungal disease complex in soybeans is caused by several species of the genus *Diaporthe/Phomopsis (D./P.).* These pathogens were first described in the USA (Lehman, 1923). Nowadays, they are widespread in soybean growing regions around the globe. Moisture and temperature in soil and air are the main factors influencing fruiting body formation, spore release, infection and the occurrence of symptoms on the plant (Vidic et al., 2011). High relative humidity is decisive for an infection of the seeds. A relative humidity of approximately 100% for an extended period of time (also during the day due to rain or fog) is a prerequisite for an extensive infection of the seeds. It can also be assumed that, even at high humidity, the average temperature must be above 15°C to trigger an infection (Balducchi, 1987).

Often, several pathogens occur simultaneously which makes it difficult to clearly distinguish the symptoms. In soy fields, the pathogens can cause considerable harvest and quality losses. Overall, the D./P. complex causes more losses than any other fungal disease of the soybean (Sinclair, 1999). The following diseases are caused by D./P:

- Phomopsis seed decay (*Phomopsis longicolla* Hobbs)
- Pod and stem blight (*D. phaesolorum* var. *soybean*)
- Northern stem canker (*D. phaesolorum* var. *caulivora*)
- Southern stem canker (*D. phaesolorum* var. *meridionales*)

1.1 Pathogens and diseases of the complex at a glance

1.1.1 Phomopsis seed decay (*Phomopsis longicolla* Hobbs)

The pathogens first attack the seed coat and then penetrate into the ovules. The infested seeds shrivel, crack and are covered by a white fungal mycelium (Fig. 1). Furthermore, the germination capacity is reduced, the composition of the constituents in the seed is changed and the proportion of split and moldy grains is increased. In severe cases this can reduce yields. Warm and humid weather from pod fill to harvest promotes infestation. In the USA, Phomopsis longicolla is the most widespread pathogen of the D./P. complex, although its occurrence varies from year to year depending on weather conditions.

Figure 1: Soy seeds infested by Phomopsis seed decay. Sources: Li, 2011; Taifun, 2010.

1.1.2 Pod and stem blight (*D. phaesolorum* var. *sojae*)

Small, black dots arranged in lines (pycnidia, Fig. 2) appear in the middle of the growing season on fallen leaves and, at the beginning of ripening (R7), on infested stems and pods. If pods and seeds are affected, yield losses may occur. The pathogens are sometimes also detectable in green plant parts without causing visual symptoms.

Figure 2: Pycnidia on pod and stem blight infested soybean stems.
Source: Taifun, 2011.

1.1.3 Stem canker (D. phaesolorum var. caulivora, D. phaesolorum var. meridionales)

This disease is divided into a northern and a southern form due to its geographical occurrence within the USA.

In the early reproductive stage of the plant, reddish-brown lesions appear on the stem near the internodes (Fig. 3). Above and below the infection site, the tissue initially remains green. As the disease progresses, the affected area spreads, becomes dark brown to black and partially constricts the entire stem interrupting the water and nutrient transport of the plant and finally leads to the death of the plants. The leaves of infested plants show yellow discolorations between the leaf veins. Dead leaves usually still remain on the plant. As with all fungal diseases, wet, warm weather promotes the development.

Figure 3: Reddish-brown lesions on the stem.
Source: UW Madison Department of Plant Pathology, 2006.

1.2 Control strategies

As the pathogens of all forms winter in infested plant residues, the infestation pressure can be reduced by the following measures: 1) crop rotation with non-host plants such as wheat or maize, 2) deep soil cultivation to bury infested crop residues and reduce the spread of spores by wind and rain, and 3) rapid harvesting of the ripe seeds.

In the USA a fungicide treatment of seeds, plants at pod filling or the cultivation of less susceptible varieties are another part of the control measures.

2. Further information

The pathogens of the genera Diaporthe/Phomopsis are plant pathogens which infest many cultivated plants (e.g. sunflower (*Helianthus annuus* L.), garlic (*Allium sativum* L.), lupin (*Lupinus spp*.) or tomato *(Lycopersicum esculentum* Mill.) (Vrandecic, 2006)). Within the *D./P.* complex *Phomopsis longicolla* is the predominant species, followed by the pathogen of the northern stem canker (*Diaporthe phaseolorum* var. *caulivora*) and the pathogen of the pod and stem blight (*D. phaseolorum* var. *sojae*) (Medić-Pap et al. 2007, Xue et al. 2007). Pod and stem blight was first observed in the USA in 1920 (Lehman, 1923), northern stem canker appeared in the 1950s and southern stem cancer in 1973 (Sinclair, 1999). Northern stem canker was also recently reported from Brazil (Costamilan et al. 2008).

2.1 Influence of Diaporthe-infestation on the seeds

Often a diaporthe infestation of more than 50% is diagnosed even for healthy looking seeds (Hepperly, 1978, Taifun 2014). Frequently the question is raised asked whether these seeds can still be used. There are contradictory statements on this, as it appears to make a decisive difference whether the pathogen is only present in the seed coat or penetrates into the cotyledons (Zorilla et al., 1994). If the pathogen is only present in the seed coat, the seedling can 'strip' the infected seed coat in the soil and thus escape the harmful adhesions (Franca Neto and West, 1989; Fig. 4). Hence, a high germination capacity can be achieved despite the infestation. Whether the additional spore input via infested seeds really has a decisive influence if the pathogen is present in the environment anyways is not discussed in the literature and must be clarified in experiments. Since the lifespan of spores in the soil is limited to 2-3 years (Hartman, 2014), the question is what role already existing spores really play in a sufficiently wide crop rotation.

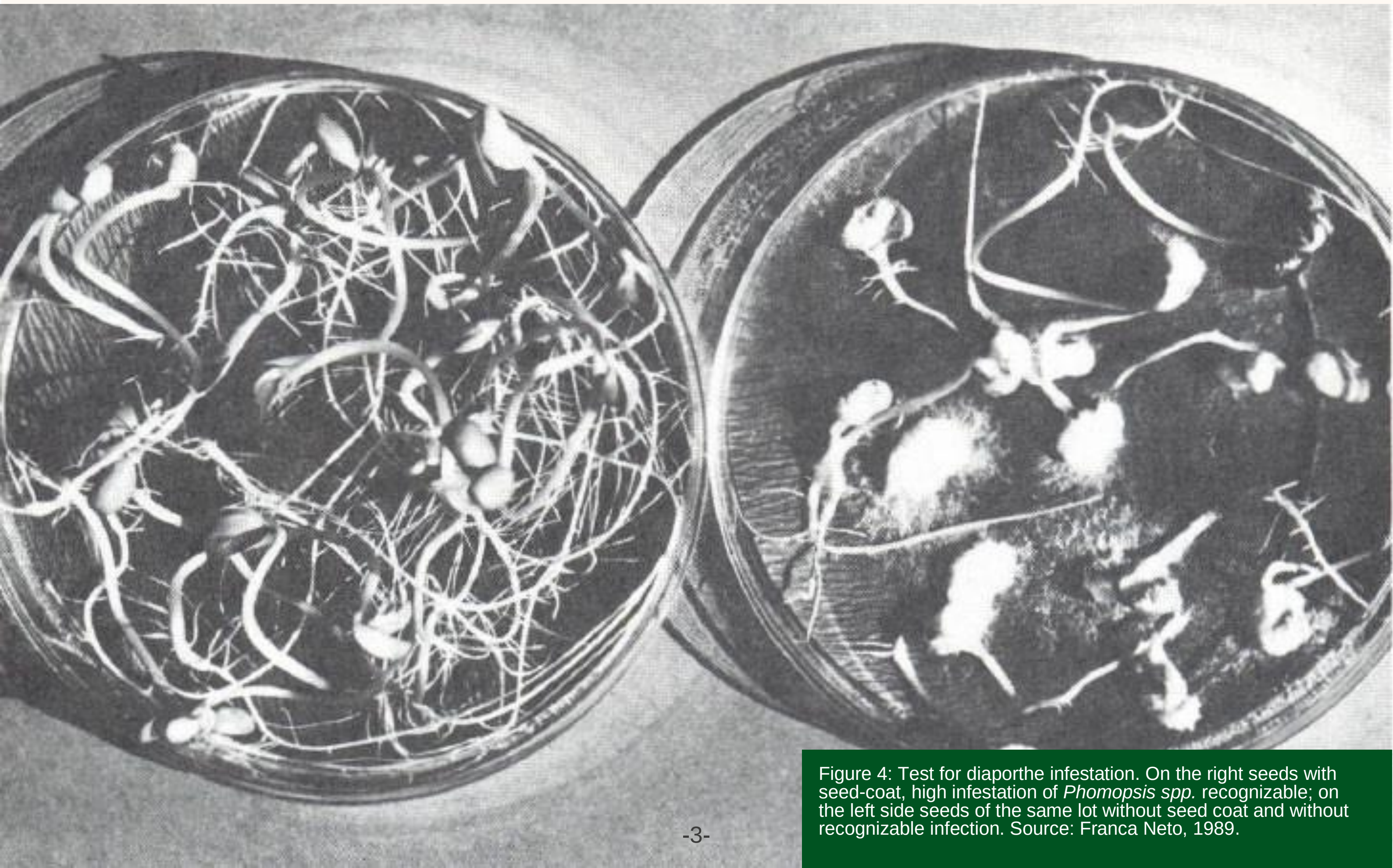

Figure 4: Test for diaporthe infestation. On the right seeds with seed-coat, high infestation of *Phomopsis spp.* recognizable; on the left side seeds of the same lot without seed coat and without recognizable infection. Source: Franca Neto, 1989.

2.2 Biology

The sexual reproduction cycle (teleomorph stage) of the fungi forms perithecia with asci and ascospores. In the asexual cycle (anamorph stage), different types of conidia (elliptical to spindle-shaped α-conidia and thread-shaped α-conidia) are formed in pycnidia (Kulik and Sinclair, 1999). The anamorph to all *D. phaseolorum* - species is *P. phaseoli*. Accordingly *P. soyae* is the anamorph to *D. phaseolorum* var. *sojae*. The species *P. longicolla* has no teleomorph.

Infected plant residues and seeds are the biggest source of infection. *Diaporthe phaseolorum* var. *caulivora* and *meridionales* form perithecia with ascospores that winter on crop residues. During the following growing season the spores infect leaves or injured parts of the plant. *Phomopsis longicolla* forms pycnidia and infects the plants with conidia. *D. phaseolorum* var. *sojae* winters as a dormant mycelium in soy or other host plants and in infected seeds (Kulik and Sinclair, 1999), which promotes long-range spread.

2.3 Pathogens and diseases of the complex in detail

2.3.1 Phomopsis seed decay

Although *Phomopsis longicolla* is known to be the primary trigger of seed decay, other morphologically different fungi of the *D./P.* complex may occur (Li and Chen, 2013). To evade the drought at the end of the vegetation period, more precocious varieties are increasingly used in the USA, which has increased the occurrence of seed decay. On the one hand, early sowing sometimes does not result in optimum soil temperatures, so that slower germination can increase infestation in warm and humid environments (Heatherly and Bowers, 1998). On the other hand, the pathogens can find optimal weather conditions for spreading in July or August, when temperatures are still warm and humidity is high (Li and Chen, 2013). The use of resistant varieties is the most effective control strategy. To date, 28 soybean lines have been identified that are, to a certain extent, resistant to *P. longicolla* (Li and Chen, 2013). However, some lines that were considered resistant in certain regions of the USA were vulnerable in other regions. Whether there are different populations at different locations is still unclear.

2.3.2 Pod and stem blight

Pod and stem blight and seed decay are sometimes not clearly distinguishable and are often described together (Iowa Soybean Association, 2010). Although different pathogens have been identified for the diseases, they are often detected in parallel. Whether pod and stem blight must necessarily end in seed decay is questionable, as well as whether one name can be seen as synonymous with the other and the diseases can be equated as this has been done by Johnson et al (2010).

2.3.3 Stem canker

Four genes have been identified as being significantly involved in resistance to southern stem canker: Rdm1, Rdm2, Rdm3 and Rdm4 (Chiesa et al. 2013). However, the presence of several genes in a variety does not increase resistance, and plants with these genes do not show resistance to northern stem canker. The strict spatial separation of the pathogens is due to their temperature optimum during mycelium growth and pathogenicity. While *D. phaesolorum* var. *meridionales* shows the highest growth rates at 30 °C, mycelium growth and the pathogenicity of *D. phaesolorum* var. *caulivora* are significantly inhibited at this temperature (Keeling, 1988).

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