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Taifun Soy Info

Specialist information for soybean producers and processors

Nematodes in soybean cultivation

Plant parasitic nematodes are typical crop rotation pests, which can develop into economically important pests within a few years in close crop rotations. With increasing soybean cultivation in Germany, the question arises whether nematodes can also cause yield losses under our local conditions. Which nematodes should be paid particular attention to and how can they be controlled? What can we learn from the experiences of other countries?

Nematodes are thread-like worms with a length of 0.4 to 8 mm. They occur in the most diverse ecosystems - in the soil, in the sea, in rivers, animals, humans and plants. In 100 ml of soil 5000 - 8000 individuals can occur, which corresponds to approx. 300 kg wet weight per hectare.

Most nematodes feed on bacteria and fungi and are thus an important part of the ecosystem. Some nematodes suck at plant roots and sometimes even penetrate the root. This damages the root tissue and hence hinders the absorption of nutrients and water. Such **plant parasitic nematodes** can cause high economic damage to crops.

However, there are also **useful nematodes**, such as e.g. nematodes of the genera *Steinernema* and *Heterorhabditis*. These genera are used very successfully in the control of insects, e.g. against larvae of *Otiorhynchus* or *Sciaridae*.

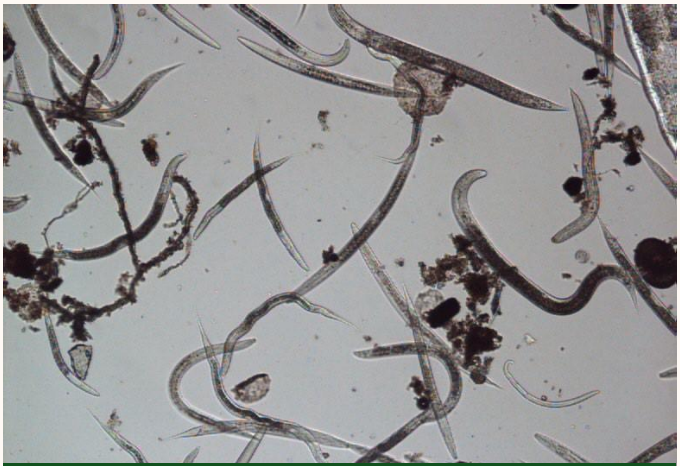

Figure 1: Free-living nematodes in a soil suspension (JKI, 2015)

Nematodes found in soybean cultivation in Germany

Very little is known about plant parasitic nematodes in soy cultivation in Germany. In 2014, the Julius Kühn Institute (JKI), Federal Research Institute for Cultivated Plants, carried out surveys on the occurrence of plant parasitic nematodes on practice areas in Bavaria, Baden-Württemberg and Rhineland-Palatinate. Soil samples were taken before sowing and after harvesting soy. Nematodes of the following genera could reproduce in soy cultivation: *Meloidogyne*, *Pratylenchus*, *Paratylenchus*, *Helicotylenchus* and *Tylenchorhynchus* (Table 1). The maximum nematode density per 100 ml soil after soy harvest was 616 individuals *Meloidogyne*, 744 individuals *Pratylenchus*, 816 individuals *Paratylenchus*, 732 individuals *Helicotylenchus* and 268 individuals *Tylenchorhynchus* (Hallmann, 2015). For most of the listed genera the nematode densities are significantly above the damage thresholds indicated for other crops. It is not yet known whether yield losses due to plant parasitic nematodes also occur in soy. As soy is a good host plant for various plant-parasitic nematodes this cannot be excluded either. First indications of a possible damage caused by plant parasitic nematodes could be that the crop no longer reacts to fertilizer application, **the growth is uneven or nest-like reduced growth** occurs. If such symptoms are noticed, the yield loss is usually already more than 10%.

Table 1: Important species of nematode genera detected in Germany on agricultural crops and their host plants (after P. Knuth, 2008).

Genus	key species	damaged crops
Meloidogyne	Meloidogyne hapla Meloidogyne naasi	Vegetables, potatoes, roses, cereals, grasses
Pratylenchus	Pratylenchus penetrans Pratylenchus crenatus	Vegetables, potatoes, corn, ornamental plants cereals, vegetables
Paratylenchus	Paratylenchus bukowinensis	Celery, carrot, rape
Helicotylenchus	Helicotylenchus pseudo-robustus	Cereals, legumes
Tylenchorhynchus	Tylenchorhynchus dubius	Cereals, corn, grasses

A striking feature of the JKI studies was the high overall reproduction rate of *Pratylenchus*. As this is known from the literature, the reproduction of *Pratylenchus penetrans* on the soy variety Merlin was studied 2014 in 1 m² micro plots at the JKI in Münster. The average multiplication rate was 67, which confirmed the very good host status of soy for this nematode species. The maximum nematode density was 5940 individuals of *P. penetrans* / 100 ml soil. This is very high as the damage threshold for other crops lies between 80 and 250 individuals/100 ml soil. The damage threshold strongly depends on the location, so that different damage thresholds can apply at different locations for the same crop. Hence, each impact must be assessed individually. In general, carrots, strawberries and potatoes are more sensitive to *P. penetrans*, whereas maize and oil radish are more tolerant. Bristle oat, ryegrass or brassicaceae are considered to be bad host plants. With cereal cultivation the population does at least not increase, but remains about the same size. The best inhibiting effect would be a three-month cultivation of the enemy plant Tagetes. If *Meloidogyne hapla* is the primary pathogen, the cultivation of cereals is recommended, since it does not reproduce on cereals. For other nematode species, other non-host plants or enemy plants shall be used accordingly.

In summary, soy is a good host plant for various plant parasitic nematodes, especially *Pratylenchus penetrans*. Close crop rotations should therefore be avoided at all costs in order to prevent the build-up of harmful nematode densities. Without a host, the population of live animals of *P. penetrans* decreases by about 50 % per year. However, as the host plants also include various weeds, control is difficult even when non-host plants are grown. Ideally, non-host plants are cultivated for 2 - 3 years. **However, whether soy is also damaged by plant parasitic nematodes is not yet sufficiently known or studied.** Little is known about the influence of the variety on nematode reproduction. The results of the survey at least suggest that the varieties differ in their host status for plant parasitic nematodes. It remains to be seen whether, in addition to the above-mentioned genera, other plant-parasitic nematodes can reproduce in soy and possibly cause damage.

Measures against the spread of nematodes

Reduced stand density which cannot be explained by a nutrient deficiency or surplus or the soil conditions, can be the result of root damage caused by nematodes. If a field is suspected of being infested by nematodes, soil samples should be taken (see below) and examined for plant parasitic nematodes. If nematodes are detected, a suitable crop rotation with corresponding non-host plants is the most effective measure against the spread and establishment of nematodes. The choice of non-host plants depends on the primary damaging nematode species. Weeds can also serve as host plants, which is why consistent weed management helps in controlling nematode densities. A healthy soil biome promotes the natural enemies of the nematodes such as fungi and bacteria and thus also prevents nematode growth.

Soil sampling

1) Recording the nematode density

To determine the current nematode density, approx. 20 punctures are taken with the sampler and combined to a mixed sample. The sampled section should be representative for the whole area. The area covered by each sample should not exceed 1 ha. Accordingly, for larger areas several samples should be taken. Depending on the results, this would also allow different proceeding.

The individual punctures are taken from the top 20 cm of the soil in a zig-zag pattern (Fig. 2) and mixed well in a bucket. About 1 l of soil is then packed in a plastic bag, sealed, labelled and sent to an appropriate testing laboratory, such as the plant protection service of the respective federal state. The sample should be stored in a cool place (6 - 8°C) until shipping. The shipment can then be carried out normally. An unbroken cold chain, as with Nmin samples, is not necessary.

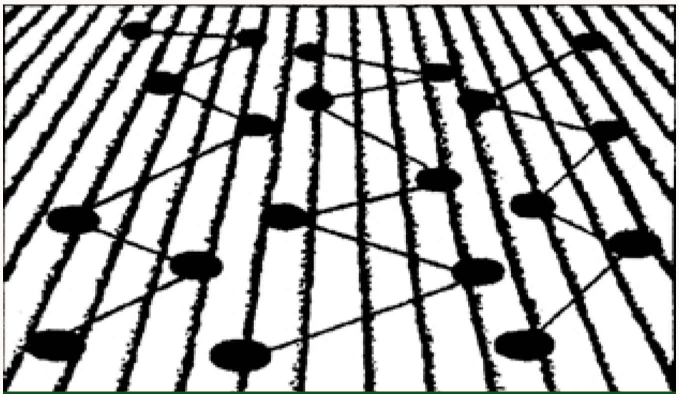

Figure 2: Soil sampling pattern to investigate nematodes (Hershman, 2009)

2) Recording the reproduction under soybean
To determine the development of the nematode population on an area, soil samples of the corresponding field are taken both before sowing and after harvest. Per field, approx. 20 punctures should be made with the sampler (to a depth of approx. 20 cm) on an area of 2 - 3 m² before sowing (Fig. 3). Exactly the same area must be sampled again six months later after harvesting. It is hence advisable to look for prominent points and to document the sampling accordingly. The individual punctures are mixed in a bucket and about 1 l of the total sample is sent to the laboratory in a plastic bag. Based on the results of the two samples (before sowing and after harvest), the reproduction rate of the different nematodes can be determined.

Figure 3: Soil sampling before sowing (Taifun, 2015).

Further information

Nematodes found in soybean worldwide

Nearly all research on plant parasitic nematodes in soybean cultivation has been carried out in North and South America and Asia. The research is focused on the locally economically important species ***Heterodera glycines***, *Meloidogyne incognita, M. arenaria, Rotylenchus reniformis, Belonolaimus longicaudatus* and *Pratylenchus scribneri*. **None of these thermophilic species occurs in Germany in the open**. An introduction of these species into Germany is extremely unlikely thanks to the well-functioning Community Plant Health System. If it should nevertheless occur, these species would probably not be able to establish themselves due to their temperature requirements.

The grower's attention must be focused on the species occurring in Germany. Unfortunately, there is still no experience from other countries on how these nematodes can be controlled in soybean cultivation. So far, we can only rely on proven countermeasures in other cultures and adapt them according to our knowledge of the biology of the nematodes. Crop rotation recommendations with corresponding non-host plants are the first and foremost.

Heterodera glycines - Soy Cyst Nematode

Life cycle

The life cycle of *H. glycines is* divided into three major stages: egg, juvenile stage (Fig. 4) and adult form. Under optimal conditions (20-24°C soil temperature) the life cycle is completed after 20-25 days (Yu, 2011). In spring, at the right temperature (from 10°C) and soil moisture, the worm-like juveniles hatch - this is the only stage in which they can attack the roots of soybeans. After they have penetrated the roots, they "migrate" in the roots until they reach the vascular tissue (xylem, phloem) where they begin to feed. Female nematodes swell and can even burst the root by their size and return to the root surface. Here they are fertilized by the male nematodes, which have migrated out of the root and die after fertilization. The females stay at the root, continue to feed and produce eggs. When their whole body is filled with eggs, they die. This egg-filled body is called a "cyst" (Fig. 5) and gives the nematodes their name. A cyst contains 200 - 400 eggs, which are protected by their solid walls and can survive in this form for several years.

Figure 4: *H. glycine* juvenile stage (Lambert, 2015).

Figure 5: Cyst of *H. glycines* filled with eggs (McGawley, 2015).

Symptoms

Infested plants initially show a heterogeneous, wavy growth. Nest-like brightening of the plants occurs, in extreme cases the plants wilt and open patches in the stand occur (Fig. 6). The infested roots are poorly developed and nodulation is reduced (Fig. 6).

Figure 6: Symptoms of *H. glycines* infestation in the field (Purdue University, 2009) and at the roots (Purdue University, 2011).

Distribution

H. glycines can move a few centimeters in the soil on their own, but is mainly spread passively by anything that moves soil particles (e.g. agricultural machinery and equipment, workers, animals, wind and water). Soil particles in the seeds can introduce the parasite when sowing in a field that is not yet infected.

In the USA, *H. glycines is* found in all soy-producing states except New York and West Virginia. *H. glycines* was first discovered in Québéc, Canada, in 2013 (Tylka and Marett, 2014).

Control

In the USA a large number of resistant soybean varieties have now been registered. Thanks to the work of many plant breeders, the yields of these varieties can now compete with those of non-resistant varieties. The degree of resistance is different for different varieties and they can reduce the reproduction of nematodes by up to 90%. However, nematodes can also develop resistance. Hence it is recommended not to use the same variety or varieties with the same resistance genes one year after the other - there is no other way than crop rotation in the fight against this disease.

Sources

Hallmann, J., 2015. Personal communication.

Knuth, P., 2008. Plant parasitic nematodes. www.landwirtschaft-bw.info.

Tylka, G.L. und C.C. Marett, 2014. Distribution of the Soybean Cyst Nematode, Heterodera glycines, in the United States and Canada: 1954 to 2014. Plant Health Progress, 15 (2), 13-15.

Qing Yu (2011). Soybean Cyst Nematode (Heterodera glycines Ichinohe), Soybean Physiology and Biochemistry, Prof. Hany El-Shemy (Ed.), ISBN: 978-953-307-534-1, InTech, http://www.intechopen.com/books/soybean-physiology-and-biochemistry/soybean-cyst-nematode-heterodera-glycines-ichinohe

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