Literature study on the host status of sugar beet for *Pratylenchus* species

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1. Introduction

In this literature study the host status of sugar beet for different *Pratylenchus* species was investigated. At IRS Diagnostics, symptoms caused by *Pratylenchus* spp. are rarely seen and not related with damage resulting in yield loss. However, sometimes they cause symptoms on the roots. This study was carried out to investigate which information is available on the host status of sugar beet for *Pratylenchus* spp.

2. *Pratylenchus* species in the Netherlands

Table 1 Ten *Pratylenchus* species are found in the Netherlands (Bongers 1994).

Pratylenchus spp (Bongers, 1994)	*Dutch name (Bongers, 1994)*	*distribution (Keidel, 2006)*	*host plants (aaltjesschema.nl)*
P. penetrans	gewoon wortellesieaaltje	common on all soil types in NL. Relative abundancy highest in zuidoostelijk zandgebied and oostelijk zandgebied.	carrot, lily, potato, chicory
P. crenatus	graanwortellesieaaltje	relative abundancy highest in zuidoostelijk zandgebied and oostelijk zandgebied. Loamy sand soils. Noordoostelijk zand- en dalgrondgebied and (zuid)oostelijk zandgebied. At low pH.	barley
P. neglectus	bietenwortellesieaaltje	most common root lesion nematode. Zavelgronden. Less common in noordoostelijk zand- en dalgrondgebied.	potato, largely unknown
P. thornei	tarwewortellesieaaltje	preference for (old) heavy soils in Zeeland and noordelijk kleigebied. Absent in centraal kleigebied.	no significant damage in the Netherlands
P. fallax	graswortellesieaaltje	only present in noordelijk kleigebied and zuidoostelijk zandgebied. In both regions very rare.	no significant damage in the Netherlands
P. vulnus	houtwortellesieaaltje	not investigated	perennials and at tree growers
P. pratensis	weidewortellesieaaltje	relatively rare. Only found in zuidoostelijk zandgebied and oostelijk zandgebied.	no significant damage in the Netherlands
P. convallariae	no Dutch name found	not investigated	perennials and at tree growers
P. flakkensis	no Dutch name found	not investigated	-
P. pseudopratensis	no Dutch name found	not investigated	-

3. *Pratylenchus* spp. and sugar beet

In literature search the combination of *Pratylenchus* species with sugar beet gives relevant hits for *P. neglectus, P. thornei, P. crenatus, P. penetrans, P. fallax, P. scribneri, P. pratensis* and *P. loosi*. In general, sugar beet is mentioned as a poor host of *Pratylenchus* spp. (Anonymous 2008). Pot experiments and glasshouse studies indicated that sugar beet can be a host for *Pratylenchus* spp., however mostly poorly (Vito *et al.,* 2002; Van Galen-van Beers *et al.*, 2001). In a glasshouse study sugar beet was a better host for *P. neglectus* compared to different populations of *P. penetrans* and *P. thornei*. However, sugar beet compared to other crops is a poor host for *P. neglectus* as well (Vito *et al*., 2002). Sugar beet roots in an *in vitro* root culture were affected by *P. fallax* and became much quicker necrotic than roots of barley and wheat. However, reproduction of *P. fallax* on wheat and barley roots was higher than on sugar beet roots (Corbett 1972). Possibly, because the roots of the sugar beet die off quickly, the host status might be bad (due to lack of available food) but the damage could be high. However, in this test no other *Pratylenchus* species were investigated as a reference for *P. fallax*. At higher temperatures, optimum temperature 33-34°C, *P. scribneri* might cause damage in sugar beet (Castillo and Vovlas 2005). In data obtained during the SUSY study in 2007-2008 no significant differences in infestation levels of *Pratylenchus* spp. were observed, for sandy nor clay soils, between average and top sugar beet growers (grower typing based on their sugar yield history) (Hanse *et al.*, 2011). In this study the following species were found: *P. penetrans, P. crenatus, P. fallax, P. neglectus* and *P. thornei,* where *P. fallax* was found on one field only. Both the relation of individual species and that of the genus with sugar beet yield was very poor and did not contribute to the explanation of the sugar yield differences between average and top growers. In one study a decrease in *P. penetrans* population of 24% in sugar beet was observed in a glasshouse experiment (Van Galen-van Beers *et al.*, 2001). However, in PPO field trials in the Netherlands, no in- or decrease in population density was observed in *P. penetrans* populations in soil before (425 larvae/100 ml soil) and after sugar beet (425 larvae/100 ml soil). Only in the control without crops (fallow) the numbers of nematodes decreased (Brommer and van Beers 2001). This indicates that sugar beet is a poor host for *P. penetrans*. Possibly, sugar beet can decrease *P. penetrans* populations at higher densities than 425 larvae/100 ml soil and could be used as a crop to reduce nematode density in the soil. A 'purifying effect' of the soil by sugar beet was described on populations of *P. penetrans* and other plant species of the genus *Beta* (Oostenbrink *et al.*, 1957). The relative amount of *P. penetrans* nematodes in the roots of sugar beet was lower than 15% compared to 164 crops (Oostenbrink *et al.*,1957). *P. penetrans* probably penetrates the roots of sugar beet without causing damage in sugar beet even in soils with high infestation of these nematodes (Anonymous 2008). It was concluded from field experiments for the most common *Pratylenchus* species in France (*P. neglectus, P. thornei, P. crenatus, P. penetrans* and *P. fallax*) that *Pratylenchus* species were present in significantly lower amounts in wheat which were grown after sugar beet compared to wheat monoculture or maize (Esmenjaud *et al.*, 1990). This result for *P. fallax* was confirmed by a study by Corbett (1972) which showed poor reproduction on sugar beet in *in vitro* tests.
The distribution of different species of *Pratylenchus* spp. was assessed in 2005-2006 for Actieplan Aaltjesbeheersing in the Netherlands (Keidel *et al.*, 2007). In seven different regions samples were taken on 425 different arable farms: *Wieringermeer en West Friesland, Zeeland, noordelijk kleigebied, centraal kleigebied, oostelijk zandgebied, zuidoostelijk zandgebied, noordoostelijk zand- en dalgrondgebied*. In all regions *Pratylenchus* was present. *P. neglectus* was present in 50% of the samples. *P. thornei* was present in 67% of the samples from *Zeeland* and in 48% of the samples in *noordelijk kleigebied*. *P. crenatus* was present in

60% of the samples from *oostelijk zandgebied*, *zuidoostelijk zandgebied* and *noordoostelijk zandgebied*.

4. Summary and discussion of relevant articles

- Numbers of *Pratylenchus* spp., (Nematoda) in the field on winter wheat in different cereal rotations. Esmenjaud *et al.*, 1990.
In France the most common *Pratylenchus* species are *P. neglectus*, *P. thornei*, *P. crenatus*, *P. penetrans* and *P. fallax*. In this study the soil and the roots of wheat (*Triticum aestivum* L. cv. Fidel) were analyzed. The soil was sampled and analyzed at several moments of the year. Densities of all species were always highest in wheat after maize. Only wheat, maize and sugar beet were investigated. Intermediate or low densities were found for wheat monocultures. Maize is a good host for particularly *P. neglectus* and *P. thornei*. Lowest densities were found on wheat after sugar beet. These significant lower densities were observed in all locations and at all sampling dates. Significant lower densities were even found in the third year wheat after sugar beet than in wheat monocultures.

- Crop rotation effects on *Pratylenchus neglectus* populations in the Root zone of irrigated potatoes in southern Alberta. Forge *et al.*, 2015.
P. neglectus has a wide host range but is most often associated with cereals and grain legume crops. There is a positive relationship between frequency of cereal cropping and population of *P. neglectus* and damage to those crops. This research: Effects of crop rotation and production practices on *P. neglectus* densities. Crops in rotation included potato (P), dry bean (DB, *Phaseolus vulgaris* L.), wheat (W, *Triticum aestivum* L.), **sugar beet (SB, *Beta vulgaris* L.)**, oats (O, *Avena sativa* L.) and timothy (T, *Phleum pratense* L.). The rotations were 3-year (DB-W-P), 4-year (W-**SB**-DB-P), as well as 5-year (W-**SB**-W-DB-P) and 6-year (O/T-T-T-**SB**-DB-P). The plots were located on sandy loam soil. The 30 year normal (1981–2010) mean annual precipitation was 352 mm with a mean annual air temperature of 5.8°C. The rotations included 'conventional' and 'conservation' practices but no significant effects were observed for populations of *P. neglectus*. The soil was sampled multiple times during the season (spring, summer and autumn) but only in the years that potatoes were grown. After a 5-year rotation population densities were significantly larger than after a 4-year and 6-year rotation at some of the sampling seasons. In the 5-year rotation the potato phase was preceded by wheat and next dry bean, while the 4- and 6-year rotations were both preceded by sugar beet and dry bean. They explain that the wheat might have caused this effect by being a good host for *P. neglectus*. These nematode numbers are based on soil and not on nematode extraction from the plant roots.

- Identification of plant-parasitic nematodes associated with sugar beet and their distribution in Hamadan Province, Iran. Karegar, 2006.
In 54,8% of the samples *P. neglectus* was found in sugar beet fields. This can be due to crops grown previously on the field which could have been good hosts for *P. neglectus*.

- Reproduction of six populations of *Pratylenchus* spp. from the mediterranean region on selected plant species. Vito, *et al.*, 2002.
In this study the reproduction of three *Pratylenchus* species (*P. neglectus*, *P. thornei* and *P. penetrans*) on several crops was investigated in the glasshouse. The numbers are only based on extraction from the roots, the soil was not analyzed. For the experiment in the glasshouse (22 ± 2°C) steam sterilized sandy soil was used. Nematode numbers are based on two repetitions of three plants of the same crop per pot. Plants were inoculated with 15,000 nematodes/pot. They don't describe that they have used a control or counted nematodes in the soil. In general few nematodes were found on the roots of sugar beets. They indicate that sugar beet was a good host for *P. neglectus*. However, the highest number of *P. neglectus*

found in the roots was 16,000 in durum wheat compared to 1,300 nematodes in sugar beet roots. They gave the LSD (P = 0.01) of 2,508 and using this value sugar beet is not significantly different from other crops (*Medicago sativa*, *Pisum sativum*, *Lens culinaris* and *Cicer arietinum)* with the lowest amounts of nematodes in the roots. However, *P. neglectus* has the highest number of nematodes in sugar beet compared to *P. thornei* and *P. penetrans* which are all below 250 nematodes. Therefore, sugar beet is a poor host for *P. thornei* and *P. penetrans*.

- Host suitability of arable and vegetable crops for *Pratylenchus penetrans*. Van Galen-van Beers, *et al.*, 2001.
Pot experiments in quartz-sand soil with among others sugar beet. They infected seedlings with 5,500 nematodes/pot in 8 replicates. The completion of one life cycle of *P. penetrans* at 20°C takes 40 days, therefore, after 6 weeks the population density was analyzed in the roots and soil. They used a mistifier to extract nematodes from the roots and the Oostenbrink elutriator to determine the amount of nematodes in the soil fraction. At the end of the experiment the amount of nematodes in the roots of sugar beet was around 4,000 and in the amount in the soil was around 200 nematodes (no exact numbers are given but low amounts for nematodes in the soil were found for all tested crops). They mention that the almost complete absence of nematodes in the soil is caused by the fact that there was no organic matter in the soil except for the roots of the seedlings. Therefore, I doubt whether the amounts of nematodes found in the roots are representative for field conditions. Maybe the results do say something about the relative host suitability. They used fallow as a control which contained only 1,500 nematodes in the soil after 6 weeks in the greenhouse; therefore, the amount of *P. penetrans* decreased by 70%. In sugar beet the number of *P. penetrans* decreased by 24%. However, not all nematodes survive the inoculation which was done using a suspension. Alfalfa was a very good host and had a final population of 6,500 nematodes in the roots which is an increase of 118%. Rye had a final population of 5,000 nematodes and asparagus 1,000 nematodes.

- The effect of *Pratylenchus fallax* on wheat barley and sugar beet roots. Corbett, 1972.
This research with *P. fallax* was done in sterile root cultures of different crops. The roots of sugar beets became much quicker necrotic after penetration of *P. fallax* than barley and wheat roots. *P. fallax* reproduced better on wheat and barley roots compared to sugar beet roots. However, also sugar beet roots were affected by *P. fallax*. In this article only *P. fallax* was investigated, therefore the quick necrotizing of the sugar beet roots should be investigated in relation to other *Pratylenchus* species. *P. fallax* is one of least common *Pratylenchus* species in the Netherlands (Keidel *et al.*, 2007).

- Morphometrics of two *Pratylenchus* species associated with sugar beet in the Eighth Region (Bio-Bio), Chile. Rubilar and Aballay, 2006.
In Chile populations of plant parasitic nematodes under sugar beet were analyzed. Only the soil was analyzed (samples of 25 ha) using Cobb sieving and Baermann funnel. The most common plant parasitic nematodes were *Pratylenchus* species: *P. thornei* and *P. loosi*. *P. thornei* is a species which is also present in the Netherlands. In this article (only based on the abstract) nothing was mentioned about possible damage or pathogenicity.

- *Pratylenchus*: Diagnosis, Biology, Pathogenicity and Management. Castillo and Vovlas, 2007.
Page 252: Distribution of *P. thornei* is associated with sugar beet on the Canary Islands.

Page 314: Study with *P. scribneri* indicated that the optimal temperature for this species is quite elevated (33-34°C) in several host plants such as sugar beet (Thomason and O'Melia, 1962).
Page 388: Very low root infections of *P. thornei* in sugar beet roots were observed (Greco *et al.*, 1988).

5. Discussion and Conclusion

The studies might not all be relevant for Dutch climate, soil types and crop rotations since some field trials were carried out at different continents and climatic zones or only *in vitro* or glasshouse. In addition, some studies were statistically not very reliable due to few repetitions used. However, some conclusions can be drawn:

- Sugar beet can be used in crop rotation to reduce amounts of several *Pratylenchus* species.
- *P. crenatus*, *P. neglectus*, *P. thornei* and *P. penetrans* are the most abundant *Pratylenchus* species found in the Netherlands on arable fields.
- Some contradictory evidence is found on *P. penetrans* in which sugar beet is described as a poor and a non-host. However, it was never described as a good host.

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