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NORSK INSTITUTT FOR BIOØKONOMI

Survival of PCN after SoilSaver steaming

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TITLE

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SUMMARY:

The purpose of the experiment was to investigate whether the Potato Cyst Nematode (PCN) will survive steam treatment in SoilSaver. The results from the SoilSaver experiments show that heat treatment with steam affects PCN's ability to hatch from the eggs. Juveniles who did hatch, died shortly after. No larvae or eggs that survived the treatment were found in any of the replications.

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Content

1 Purpose

The purpose of the experiment was to investigate whether the Potato Cyst Nematode (PCN) survives after treatment with steam in SoilSaver.

2 Introduction

The Potato Cyst Nematode (PCN) are a global plant pest that can cause extensive damage to potatoes. PCN are specialized, capable of surviving long periods without a host plant and are easily spread through infected soil (Brodie and Marks 1998). Limited access to resistant potato varieties and chemical measures makes it challenging to control PCN and this is the main reason PCN is considered a global quarantine pest (LMD 2019) (EPPO 2023).

PCN originates from the Andes in South America and was likely introduced to Europe when breeding for resistance against late blight (*Phytophtora infestans*) in the middle of the 19th century (Brodie and Marks 1998). In Norway, PCN was first detected in 1955 (Øydvin 1978) and is now apparent in all potato growing districts north to Trøndelag.

PCN survives for an extended period in the soil. The eggs are protected inside cysts and can survive in soil without a host plant for over 20 years (Varandas et al. 2020). The larvae hatch from the eggs only when they detect signal substances from the roots of a host plant. The larvae move towards the root, penetrate the root tissue, and establish a feeding site inside the root. After a while, the female swells into a white or yellow sphere filed with eggs. Towards the end of the season, the female dies and transforms into a cyst that falls off the root. The cyst can contain as many as 400 eggs, which will remain inside the cyst until a new host plant induces hatching (Brodie and Marks 1998).

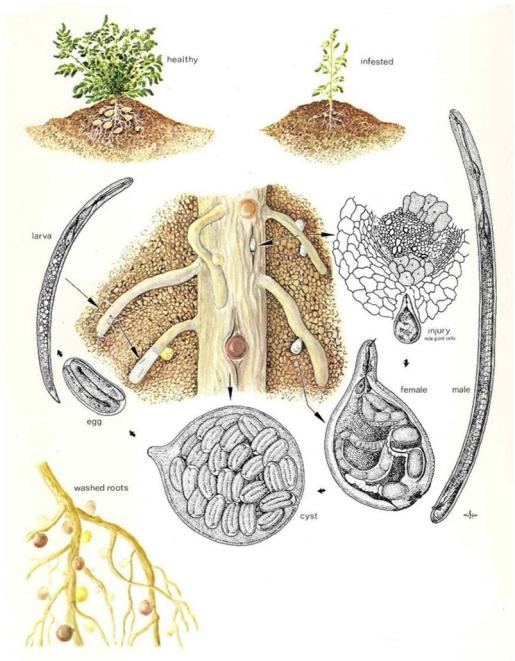

Figure 1. PCN life cycle (Wainer and Dinh 2021)

Because the eggs can survive for an extended period inside the cyst, management of PCN are challenging. Areas with PCN findings are therefore subject to strict restrictions for many years. In the case of detecting white PCN in Norway, the affected area will be placed under a 40-year quarantine.

3 Method

3.1 Multiplication of cyst for the steaming experiment

Globodera rostochiensis were cultivated on a susceptible potato variety (mandel) in a growth room. The starter cysts were enclosed in nylon bags (infection units) with 20 cysts in each bag. The infection units were placed in pots with potatoes in a growth room under controlled conditions. After three months the soil was extracted using a Fenwick can (EPPO 2013). The cysts were then dried and stored at 4 ℃ for six months to break diapause. After the resting period, new infection units were created with 20 cysts in each bag for use in the experiment.

Figure 2. Cysts and infection units used in the experiment. Photo: M. S. Vennatrø

3.2 SoilSaver Experiment

Infection units were exposed for steam in the SoilSaver process. The experiment consisted of seven replicates exposed to the same temperature profile. After treatment, the infection units were stored at 4 ℃ for four weeks before the hatching experiment was initiated.

3.3 Hatching of cysts from steaming experiment

Infection units were placed in glass containers with potato exudate for hatching, as described in EPPO (2017). Every seventh day, the root exudate was changed, and the number of hatched larvae was recorded. The process was repeated for six weeks. In the final recording, the cysts were crushed, and the remaining content (alive/dead larvae) inside the cysts was documented.

Figure 3. Cysts and infection units used in the experiment. Photo: M. S. Vennatrø

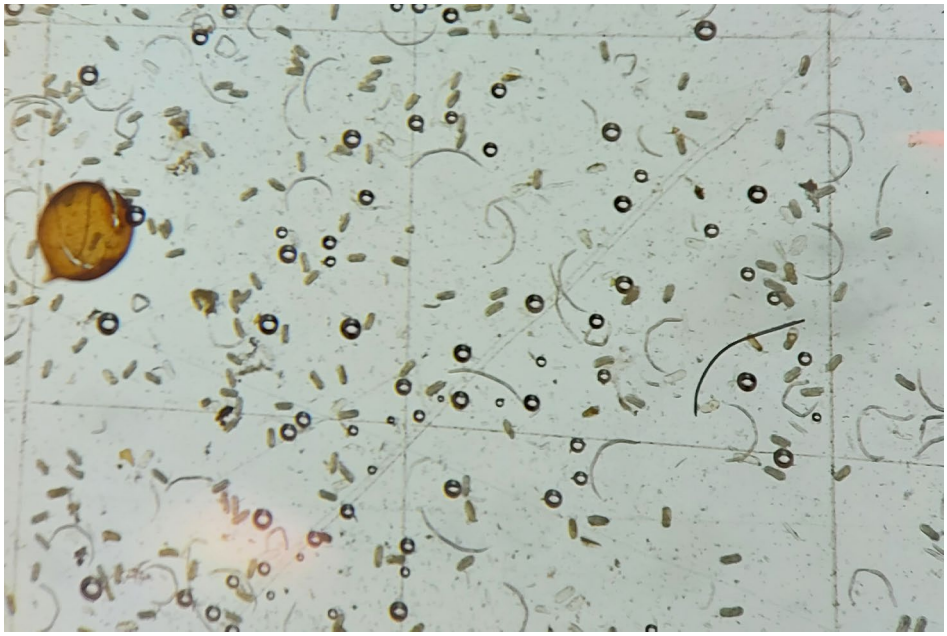

Figure 4. Cyst with dead eggs and larvae. Photo: M. S. Vennatrø

4 Results

Table 1. Number of eggs and juveniles found in the hatching experiment.

Replicate	Number of juveniles and eggs							
	Control*	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	Cyst content at end
1	5802	0	0	3 dead	7 dead	0	0	4.200 dead
2	4681	0	0	0	0	0	0	10.000 dead
3	4251	0	0	0	0	0	0	5.100 dead
4	5706	0	0	0	0	0	0	7.000 dead
5	4914	0	0	0	0	0	0	6.900 dead
6	5965	0	0	0	0	0	0	7.100 dead
7	6048	0	0	1 dead	0	3 dead	0	6.500 dead

*Only living content

No living eggs or juveniles were found in any of the replicates. In replicate one and seven, dead juveniles were found after day 21, day 28, and day 35. These juveniles might have hatched from the egg but then subsequently died. Examination of the cyst contents at the end of the experiment shows that the cysts contain a significant number of dead larvae and eggs. The high hatching frequency of the control-cyst suggests that the content in the cysts was viable at the start of the experiment, and that the treatment has led to the death of eggs and larvae.

5 Conclusion

The results from the SoilSaver experiments show that heat treatment with steam affects PCN's ability to hatch from the eggs. Juveniles who did hatch, died shortly after. No larvae or eggs that survived the treatment were found in any of the replications.

6 Literature

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BIOØKONOMI

Norsk institutt for bioøkonomi (NIBIO) ble opprettet 1. juli 2015 som en fusjon av Bioforsk, Norsk institutt for landbruksøkonomisk forskning (NILF) og Norsk institutt for skog og landskap.

Bioøkonomi baserer seg på utnyttelse og forvaltning av biologiske ressurser fra jord og hav, fremfor en fossil økonomi som er basert på kull, olje og gass. NIBIO skal være nasjonalt ledende for utvikling av kunnskap om bioøkonomi.

Gjennom forskning og kunnskapsproduksjon skal instituttet bidra til matsikkerhet, bærekraftig ressursforvaltning, innovasjon og verdiskaping innenfor verdikjedene for mat, skog og andre biobaserte næringer. Instituttet skal levere forskning, forvaltningsstøtte og kunnskap til anvendelse i nasjonal beredskap, forvaltning, næringsliv og samfunnet for øvrig.

NIBIO er eid av Landbruks- og matdepartementet som et forvaltningsorgan med særskilte fullmakter og eget styre. Hovedkontoret er på Ås. Instituttet har flere regionale enheter og et avdelingskontor i Oslo.

Front Page Photo: **SoilSteam International**

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