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PLANT PARASITIC DITYLENCHIDS IN ESTONIA

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Abstract

The first crop losses caused by potato rot nematode (*Ditylenchus destructor* Thorne) in Estonia have been reported since 1950s. Today ditylenchids are considered common but generally neglected as harmful pests with the exception on certain crops. This has resulted in serious consequences for seed potato producers in several cases. The current state of the national research and surveillance is reviewed and pest management strategies are discussed to provide general recommendations for overcoming such difficulties.

Key words: *Ditylenchus*, potato rot nematode, pest free place of production.

Introduction

Potato rot nematode, *Ditylenchus destructor* Thorne has been recognised as a serious pest of potato in Estonia since 1950s. During the last peak of damage severity, it was evaluated to cause greater crop losses than potato cyst nematode, *Globodera rostochiensis* Wollenweber /Krall, 1974/. The distribution of the species is wide /Krall, 2001/. The survey in the middle of 1950s found infestations in Tartu, Harju, Kohtla-Järve, Valga and Pärnu regions /Krall, 1958/. Potato rot nematode causes dry rot of tubers that can turn into soft rot in time. There are not many investigations on biology and ecology of potato rot nematode in the world. Somewhat better is the situation with stem and bulb nematode, *Ditylenchus dipsaci* Kühn. This paper reviews critically the available information on plant parasitic ditylenchid species in order to clarify the pest status in the country.

Materials and Methods

Stem and bulb nematode, *D. dipsaci* was reported to be introduced to Estonia annually by the international trade of onion seeds already in the beginning of the 20th century /Zolk, 1935/. Stem nematodes (under the name *Tylenchus dipsaci* Kühn) were known to infest stems of grasses and clover as well as potato and onion. However, unlike potato cyst nematode, *G. rostochiensis*, seed and leaf gall nematode, *Anguina tritici* Steinbuch and strawberry crimp nematode, *Aphelenchus fragariae* Ritzema Bos they were not considered to be of quarantine significance as they did not seem to survive for establishment in the region.

First systematic research records on potato rot nematode, *D. destructor* in Estonia originate from prof. Eino Krall who started field survey of potato nematodes in Tartu region in 1954. The survey was extended for following years up to 1959 in the territory of whole republic /Кралль, 1959/. In total 553 samples were taken from 63 localities, and nematode species were determined in 87.7% of the samples. Survey samples included aerial parts, roots and tubers as well as rhizosphere soil of potato plants. Nematodes of plant tissues were extracted by Baermann funnel method while initially 10 cm^3 soil samples were filtered through four 80 µm sieves. In order to increase efficiency, direct observation method of 1g soil samples in water was applied in the latter stages of the study. Nematodes were fixed by formalin and transferred through glycerine-ethanol method to permanent glycerine-gelatine mounts. Potato rot nematode was detected only once in aerial parts of plant, but it was a common species among the nematofauna of potato tubers, attaining maximum population only by the end of winter storage period. For detection of tuber infestation, Krall (1974) used the following method: after soaking the tubers in water for a few hours, decanted suspension was pipetted on the clean glass slide for direct observation by dissecting microscope. Alternatively the suspension can be decanted from pieces of white tuber tissue detected under the potato peelings or between rot-affected and healthy tissues.

Prof. Krall and his team in the Institute of Zoology and Botany of Estonian Academy of Sciences acted many years in functions of national reference centre for nematode diagnostics. They received samples from producers consisting of some tens of grams of soils and parts of fibrous roots of symptomatic plants, or aerial parts if distortion of aboveground organs occurred /Krall, 1965/.

The status of *D. dipsaci* complex has not been subjected to thorough studies, partially because of the difficulties to determine the phylogenetic species or trophic races /Чижов, 2006/. There have been indications of damage on onion in Peipsi lake region /Krall, 1965/, daffodils in Tartu /Кралль, 1985/, red clover in Tartu and Pärnu counties /Krall, 1965/, white clover in Tartu region Nõo and lucerne in Hiiumaa Kassari /Krall, 2001/, on tulips and in 1955 on rye /Krall, Luik, 2000/. In addition to this, there are records on findings of ditylenchids in natural plants and weeds. Root-gall nematode, *D. radicicola* Greeff has been indicated to be under pathogenecity studies to determine the damage potential for barley /Кралль, 1965; Krall E., Krall H., 1968/. There have been no records of rice stem nematode, *D. angustus* (Buther) Filipjev and *D. mycelophagus* Goodey in Estonia /Krall, Luik, 2000/.

In the middle of the 20 century progress was made in the field of nematode ecology. Some field and laboratory research has been performed to investigate behaviour of other phytopathogenous nematodes like *Globodera rostochiensis* /Mägi, 1983/, *Heterodera trifolii* Goffart /Рийспере, Роосма, 1985/ *H. avenae* Wollenweber /Мяги, 1989; Krall, Müür, 1999/, *Paranguina radicicola* Kirjanova /Krall E., Krall H., 1968/. However, there are no recent ecological studies on ditylenchids in Estonia.

Estonian phytonematology has been focussed mainly on faunistic studies by professor Krall and his team. Recently cooperation with nematologists from other countries has determined the phylogenetic relationship between 23 populations of *D. dipsaci* and developed species specific primers for identification of *D. dipsaci sensu stricto* /Subbotin et al., 2003; 2005/. The higher education quality assessment has evaluated prof. Krall's work in the structures of Tartu University and concluded the situation in 2000 satisfactory /Nikinmaa et al., 2000/. The valuable and extensive nematode collection of the Institute of Zoology and Hydrobiology has not been assimilated into zoological collections of Tartu University nor to the study collections of Estonian University of Life Sciences. The critical review of the collection has been performed to compile a databank /Krall, 2000/. Unfortunately, the majority of the nematode slides are deteriorated by today, which indicates the need to start using a different methodology for preparation of permanent mounts.

Currently no data is published on the quantity of national surveillance samples taken during the Soviet period and found positive for *D. dipsaci* or *D. destructor*. National Plant Protection Board started to promote rot-nematode-free seed potato production in 1960s /Kikas, 1969/. They recommended a complex of control measures including a general detection survey of *D. destructor*, practice of crop rotation with potato-free period of 4–5 years, pest free seed potato, and weed control.

Distribution level of potato rot nematode was estimated by Randalu (1971) based on the seed potato quality analyses in spring 1970 by the National Plant Protection Board which resulted in 50% infection by *D. destructor*. Since 1973 there have been records on the regular work of certification commission for seed potato super elite and elite categories /Rosenberg, 2002/. In 1984 a new seed potato production scheme was enforced by Agricultural Industry Assembly to use only in vitro basic material. By 1992 100% of super elite originated from in vitro clone cultures. Since 1994, EVIKA laboratory lost the possibility to multiply the protected varieties that lead to sudden decrease of certified seed potato production area from 1300 ha to 76 ha in 1999 /Rosenberg, 2002/.

Table. Results of national surveillance sampling (reason indicated) and findings of *Ditylenchus* destructor (DITYDE) and *D. dipsaci* (DITYDI)

YEAR	Seed potato tuber analyses			Monitoring of ware potato bacterial diseases		Tuber analyses on producer's request	
	No of samples	Positive DITYDE	Positive DITYDI	No of samples	Positive DITYDE	No of samples	Positive DITYDE
2003	97	0	0	unknown	6	unknown	0
2004	80	0	0	unknown	0	unknown	0
2005	151	2	0	unknown	2	unknown	0
2006	195	0	0	357	3	unknown	0
2007	156	0	1	unknown	1	3	1

Data source: Estonian Plant Production Inspectorate, annual plant health surveillance reports, www.plant.agri.ee

Phytosanitary regulation under the Seed and Propagating Material Act has set the requirement of soil freedom from *D. destructor* in seed potato production. Annually, nematode freedom shall be verified by four 250 ml soil samples per hectare taken by an authorized sampler and analyzed in Plant Health Laboratory of Estonian Agricultural

Research Centre. However, as indicated in the current regulation, the soil sample is used for potato cyst nematode analysis only /Seemnekartuli kategooriad …, 2006/. Official tuber quality check by inspectors of Estonian Plant Production Inspectorate is a random sampling, a ratio of which depends on the lot size: one sample of 200 tubers shall be taken per lot size up to 20 t, two samples per 60 t, 3 samples per 100 t and from there on additional one sample per every 50 t /Seemnekartuli kategooriad …, 2006/. Table presents official analysis results on ditylenchid pests in the course of Plant Production Inspectorate national surveillance activities in recent years by plant health laboratories.

Results and Discussion

Nematology research in Estonia started not before 1930s. Even then the lack of taxonomic and ecological knowledge made the agricultural stakeholders not to adopt official phytosanitary measures for ditylenchids. Activation of research and national surveillance in 1960–70s indicates serious economic consequences occurring at that period. Krall /Кралль, 1959/ reports regular 6–7% infestation of potato rot nematode in storages and suggests the pest was widely distributed in continental part of Estonia already in 1953 when first notifications of pest damage appeared. Kikas (1969) illustrates the pest severity by examples from Tõrva region where about 50% of tuber crop was infested by the end of growing season when healthy (symptomless) seed was planted on a possibly contaminated soil. Next year there were 80–90% tubers infested on the same plot planted with tubers from the previous yield.

Mass and single clone selection and indexing have been systematically employed as quality measures in Estonian seed potato production due to the possibility of export since 1930s /Võsaste, 1971/. Production experiments for disease eradication were started by Estonian Research Institute of Agriculture by E. Kaarep in 1958 /Jaanvärk, 1966/. During the early years mainly fungal diseases and potato viruses were targeted. Sinijärv (1971) has discussed how potato rot nematodes were distributed by the means of contaminated seed potatoes. Due to higher procurement price of ʽJõgeva kollane', this table potato variety production was forced. We may guess that abnormal demand and poor supply created the market for low-quality seed. Sinijärv (1971) admits that all producers of ʽJõgeva kollane' elite seed had soils infested with potato rot nematode and instructs for usage of pest-free fields for seed production. In order to escape incidental contamination of seed potato production field by uncooperative private farmers he advises formation of seed potato production region by the example of the Netherlands, Germany, Denmark, Finland etc. Although this was not approved back in Soviet period, we urge that current regional development initiatives could still benefit from the idea.

Many authors have stressed the importance of healthy planting material, general sanitation measures like removal of infested tubers from the field and storage as well as crop rotation as main instruments to control and prevent the spread of *D. destructor*. Sturhan and Brzeski (1991) declared crop rotation in 3–4 years with cereals and maize together with weed control as exceptionally effective. Estonian sources claim the nematode is unable to survive in soil under cereals for 5 years /Kikas, 1969, Hiiesaar, Metspalu, 2002/. Nevertheless, according to a chief inspector Elsa Aru (personal communication) there have been instances with contaminations of pedigree seed potato nuclear stock occurring at least 5 years after last potato crop grown in the soil. The polyphagous habits of the nematode and wide host range (over 70 plant species and the same amount of fungal hosts according to Manzanilla-López et al., 2004 allow) us to notify that the species can be able to maintain the population in former potato fields for an undetermined period.

Fluctuation of potato rot nematode population density is proposed by Gul'skova /Гульскова, 2006/. She reports the peak of potato rot nematode damage in the former Soviet Union remaining in 1960–70. The problem in Estonia was alleviated by starting to use in-vitro cultured basic material, informing state farms' agronomists and seed potato producers of potential threats and by changing the varieties to more resistant or tolerant ones. In the middle of 1990s, neither stem nor potato rot nematodes were considered among 55 major crop pests and 50 diseases for annual national prognosis survey /Taim, Soobik, 1994, 1996/. Re-appearance of the problems now, more than ten years later, indicate that Estonian soils may have been carrying low level of infestation ever since it was first discovered in the middle of the 20th century. Collapse of the soviet seed potato propagation and national surveillance system in 1990s may have been another serious setback from potato health point of view. More studies are needed to investigate causative factors of such population build-ups as well as multitrophic relationships with ditylenchids in various soil types.

Some countries have recommended soil fumigation to destroy harmful nematofauna. Soil solarization may be considered ineffective due to lack of sun radiation intensity in our latitude. In Estonia, karbation has been recommended as soil disinfectant back in 1960–70s /Krall, 1965; Kikas, 1969/. Reluctance of plant producers to adopt this as a common practice due to its toxicity to plants has helped to preserve natural biological diversity in soils /Krall, 2000/. Hiiesaar and Metspalu (2002) admit lack of effective control measures against potato rot nematode and suggest agrotechnological methods. Currently there is no research available on damage threshold or biodiversity assessment in Estonian conditions for advisory purposes to guide integrated control strategies.

Many countries with agricultural sector being of major importance in the economy have targeted ditylenchids by legislative measures. According to Lehman (2004), it has been an increasing trend among countries as *D. dipsaci* was reported to be regulated in 23 countries in 1982 while by 2000 the number has doubled – 58. The same figures for *D. destructor* are 12 and 53, respectively. Hockland and her co-workers suggest this is because those species are easily transported in the international plant trade due to their endoparasitic nature /Hockland et al., 2006/. The fact that ditylenchids in Estonia (as well as in Europe in general) are listed as harmful organisms only in the case of plant propagation material means they are not considered of quarantine but regulated non-quarantine significance. This status is still incomprehensible for government officials in many countries, and may give a rise to some international phytosanitary disputes under International Plant Protection Convention or WTO Agreement on Sanitary and Phytosanitary Measures.

The current legal regulation defines the requirement of absence of the potato rot nematode in the seed potato, but control mechanism of this has not been introduced, apart from the random visual tuber check. However, light infestation can easily be overlooked by visual check since the exterior appears healthy /Kikas, 1969/. As indicated in Table, all official samples of ditylenchids in recent years have been taken due to other tasks and no potato rot- or stem and bulb nematode monitoring has been carried out. In fact, data on nematode status of soils are not systematically recorded, which may lead to silent build-up of pest populations in consecutive ware potato cultivation. There have been cases of rejection of seed potato lots due to infestation by *D. destructor*. This causes the producers to lose their annual income as well as initial investments as they cannot market the contaminated yield by the purpose. Ware potato producers with identified infestation are advised by national inspectors not to grow potatoes in their fields. Although there is a legal option for producers to apply for a Pest Free Area or Pest Free Place of Production according to Plant Protection Act, no steps for putting this into effect seem to have been taken.

Conclusions

With respect to restriction of spread of potato diseases, a requirement for registered ware potato producers was enforced since the 1st of January 2006 to replace 20% of planting material with certified seed. Nevertheless, using not-certified 80% of the planting material, if not analyzed on producer's own initiative is the source of constant hazard. We conclude that Estonian agricultural policy should set an aim to eradicate potato rot nematode or stem and bulb nematode along with trying to achieve at least production site freedom for plant propagation material. This could be the only effective way to preserve the remaining nematode-free fields and to support competitiveness of Estonian crop seed and seed potato producers on international markets. For ware potato production, a systematic survey of damage threshold levels per soil type should be performed.

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