Neth. J. PL. Path. 88 (1982) 155-161

The occurrence of Rhizoctonia solani on subterranean parts of wild plants in potato fields

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Accepted 12 February 1982

Abstract

The subterranean parts of 1585 wild plants (weeds) belonging to 52 species, found in potato fields in the northern part of the Netherlands were examined for the presence of *Rhizoctonia solani.* The fungus could be isolated from 30 plants belonging to 12 species. Of these isolates 62% proved to be pathogenic to potato sprouts.

Some species seemed more frequently colonized by *R. solani* than others, particularly *Solanum nigrum, Elytrichia repens* and *Matricaria recutita.* On some common weeds, viz. *Chenopodium album* and *Poa annua,* no *R. solani* was observed, while about 1% of all *Polygonum persicaria* were infected.

Disease symptoms were only observed once on *Elytrichia repens* as 'sharp eyespots', presumably caused by *R. cerealis.*

The incidence of *R. Solani* on weeds increased markedly towards the end of the growing season.

Additional keywords: weeds, pathogenicity

Introduction

Rhizoctonia solani Kühn is the imperfect stage of a primitive soil inhabiting basidiomycete, *Thanatephorus cucumeris* (Frank) Donk.

Most strains have a good competitive saprophytic ability and some seem to be able to live as saprophytes. The pathogenic strains, however, are most important to man as they form a threat to the quantity and quality of crop yields.

The fungus occurs worldwide and is very plurivorous. Mordue (1974) mentioned more than 250 plant species which may be attacked by this pathogen.

Jager and Velvis (1980) could still find *R. Solani,* although at a low level, in fields on holocene, marine soils on which no potatoes had been grown for ten or twelve years. In one field on which grass had been grown for seven years, large numbers of sclerotia were present on tubers of plants grown from clean seed potatoes, but damage to stems and stolons was very low. In some fields on pleistocene acid sandy soils the production of sclerotia on tubers of plants from clean seed potatoes was even higher than on those from infected seed potatoes, but the damage to stems and stolons of the former was distinctly lower than to those of the latter. In these cases saprophytic strains were apparently involved.

The survival of the various *Rhizoctonia* strains may be due to other crops or weeds acting as hosts. The presence of *R. solani* on roots of wild plants was observed by

Daniels (1963). Griesbach (1975, 1980) and Griesbach and Eisbein (1975) made elucidating studies on the importance of weeds in the spread and survival of *R. solani* in a sand and in a loess soil. Weeds were artificially infected with *R. solani* and its presence on the root surface and in the outer cell layers (epidermis and cortex) was noted. It was found that *R. solani* could spread from roots of infected weeds to roots and stolons of potato plants and vice versa. Areas in a field with a high weed density usually contained more potato plants infected with *R. solani* than areas free from weeds.

The purpose of this study was to examine:

a. the presence of *R. solani* on subterranean parts of weeds in potato fields in the northern part of the Netherlands,
b. to determine which weeds are most frequently colonized or infected by *R. solani,*
c. whether the *R. Solani* present on those weeds is pathogenic to potato (sprouts) and,
d. whether during the growing season variations do occur in the number of infected weed plants.

Methods

During the growing season of 1979 weed plants were collected four times in and outside experimental plots in potato fields (Jager and Velvis, 1980). Usually a few specimens of each species were collected par sampling. The subterranean parts of the stems and the roots were examined for the presence of dark hyphae with a dissecting microscope. Stem and root parts with hyphae of this type were cut out and plated out on malt-biotone agar containing antibiotics to suppress bacterial growth (15 g malt extract + 2.5 g microbiotone + 10 g agar (Oxoid no. 3)) per liter water; after sterilization and cooling to 40-45 °C, 50 mg of each aureomycin, neomycin-sulphate and streptomycin-sulphate were added per liter.

If the fungus turned out to be *R. solani,* a pure culture was made and preserved for further study.

Pathogenicity tests were performed with disinfected sprouting potato tubers grown in perlite and for some isolates also in vermiculite, in 1 l glass beakers. Three or four agar discs with hyphae and/or sclerotia of the isolate to be tested were laid on each tuber. Two tubers were planted in each beaker and then incubated at 15 °C. Two beakers were used for each isolate. Damage to the sprouts was evaluated three weeks after planting. Isolates causing damage were regarded as pathogenic to the potato plant.

Results and discussion

During the growing season the subterranean part of 1585 wild plants belonging to 52 species were examined for the presence of *R. solani* (Table 1). Some plant species were represented only by a few (less than 10) specimens; no *R. solani* was observed on these species. Hyphae of *Rhizoctonia* were found on about 2% of alle plants examined.

Some species were rarely or not at all colonized by *R. solani,* among which *Capsella bursa-pastoris, Poa annua, Polygonum aviculare, Polygonium convolvulus* and *Thlaspi arvense* (Table 1). According to Daniels (1963) and Griesbach (1975), however, these species are often colonized by *Rhizoctonia.*

Species on which *R. solani* was found to be present in our fields were *Solanum nigrum* (5 out of 42), *Lolium perenne* (1 out of 11), *Geranium molle* (1 out of 12), *Ely-*

Table 1. Species and numbers of wild plants examined for the presence of *Rhizoctonia solani* and the frequency of its occurrence (number and percentage).

Plant species	Number examined	Number with *Rhizoctonia*	Percentage with *Rhizoctonia*
Altriplex patula	14	0	
Brassica spec.	14	0	
Capsella bursa-pastoris	34	1	2.9
Chenopodium album	153	0	
Cirsium arvense	31	1	3.2
Elytrichia repens	172	9	5.2
Equisetum sp.	10	0	
Fumaria officinalis	36	1	2.8
Galium aparine	52	0	
Geranium molle	12	1	8.2
Gnaphalium uliginosum	16	0	
Lamium purpureum	97	0	
Lolium perenne	11	1	9.1
Matricaria recutita	109	4	3.9
Poa annua	113	0	
Polygonum aviculare	37	1	2.7
Polygonum convolvulus	76	1	1.3
Polygonum persicaria	194	2	1.0
Senecio vulgaris	13	0	
Solanum nigrum	42	5	11.9
Sonchus arvensis	22	0	
Spergularia arvensis	23	0	
Stellaria media	113	2	1.8
Thlaspi arvense	51	0	
Veronica chamaedrys	10	0	
Veronica hederifolia	15	0	
Vicia sativa ssp *angustifolia*	16	0	
Total	1482	29	

Less than ten plants of the following species were examined: *Aethusa cynapium, Alopecurus myosuroides, Arabidopsis thaliana, Beta vulgaris* ssp. *vulgaris, Cirsium palustre, Coronopus squamatus, Erodium cicutarium, Euphorbia helioscopia, Galeopsis tetrahit, Galinsoga ciliata, Holcus lanatus, Hordeum murinum, Juncus bufonius, Lapsana communis, Mentha aquatica, Myosotis ramosissima, Plantago major, Polygonum mite, Ranunculus repens, Rumex acetosella, Stachys palustris, Trifolium* sp., *Tussilago farfara, Vicia* sp., *Viola arvensis.*

Tabel 1. Het aantal op Rhizoctonia solani onderzochte, en het aantal en percentage met R. solani bezette wilde planten.

trichia repens (10 out of 172), and *Matricaria recutita* (4 out of 109). *Solanum nigrum* was also found by Griesbach (1975) to be a good host plant.

Rhizoctonia was usually present in the form of dark hyphae; a sclerotium was found only once on roots of *Geranium molle* and also the perfect stage was found only

Fig. 1. The occurrence of Rhizoctonia solani on weeds in potato fields during the growing season.
The number of plants examined per week is given.

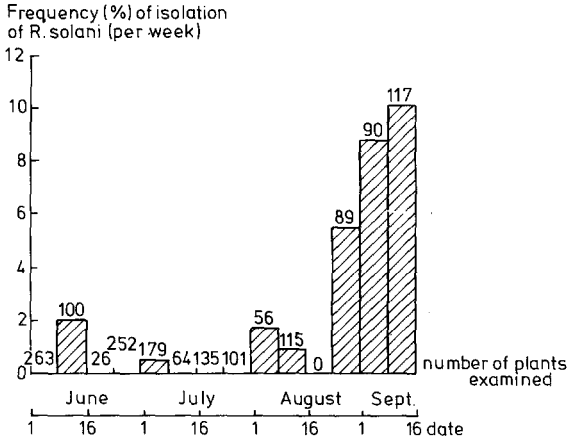

Fig. 1. Het voorkomen van Rhizoctonia solani op onkruiden in aardappelpercelen gedurende het groeiseizoen. Het aantal planten, dat per week is onderzocht, is vermeld.

once on the stem base of *Solanum nigrum*. At one time symptoms of disease were observed in the form of sharp eyespots on a stem of *Elytrichia repens*, presumably caused by *R. cerealis* Van der Hoeven (see Boerema and Verhoeven, 1977). Isolates of *R. cerealis* (narrow hyphae, with two nuclei in their cells) were found only twice, viz., once from roots of *Fumaria officinalis* and once from *Solanum nigrum*. Isolates from graminaceous plants were of *R. solani* having at least six nuclei in their unbranched cells.

The number of cases during a growing season that *Rhizoctonia* was isolated from subterranean plant parts is indicated in Fig. 1. It was very low until the end of the growing season in August and September, when much higher numbers were obtained.

The pathogenicity of *Rhizoctonia* strains from weeds to the potato plant is of interest with regard to:

1. the survival of pathogenic *Rhizoctonia* strains on weeds or their residues (Griesbach, 1980);
2. the possibility of infection of the potato plants via weeds (Griesbach and Eisbein, 1975);
3. the necessity to destroy typical host weeds in the fields.

Table 2 lists the *Rhizoctonia* isolates obtained from different weeds together with the disease index of potato sprouts as a measure of their pathogenicity.

The most important weeds in this respect seem to be *Elytrichia repens* and *Solanum nigrum* as they were most frequently colonized by *Rhizoctonia*. *Polygonum persicaria*, although less frequently colonized, is a common weed and thus may be an important source of *Rhizoctonia*, especially in sandy soils.

In the pathogenicity test of the *Rhizoctonia* isolates it was found that the disease rating of plants grown in perlite was often high and that sometimes mechanical damage to the sprouts occurred. The hard and sharp perlite pieces could cause wounds

Table 2. *Rhizoctonia* isolates obtained from different weeds and their degree of pathogenicity to potato sprouts in perlite and in vermiculite.

Strain	Isolated from	Disease index[1]	
		perlite	vermiculite
RAO 1	*Elytrichia repens*	17;1	–
RAO 2	idem	0	–
RAO 10	idem	0	–
RAO 12	idem	50;5	66;1
RAO 13	idem	60;4	40;1
RAO 14	idem	25;5	40;1
RAO 15	idem	50;5	25;1
RAO 17	idem	17;2	19;3
RAO 12	*Solanum nigrum*	57;4	–
RAO 5	idem	0	–
RAO 6	idem	0	–
RAO 19	idem	33;2	38;4
RAO 20	idem	80;5	–
RAO 7	*Polygonum persicaria*	25;5	–
RAO 9	idem	20;5	–
RAO 11	*Polygonum aviculare*	0	–
RAO 18	*Polygonum convolvulus*	30;5	44;4
RAO 8	*Stellaria media*	0	–
RAO 16	idem	0	–
RAO 21	*Matricaria recutita*	25;5	0
RAO 22	idem	59;4	0
RAO 23	idem	0	–
RAO 24	idem	0	–
RAO 26	*Capsella bursa-pastoris*	43;5	43;4
RAO 27	*Cirsium arvense*	75;4	0
RAO 25	*Lolium perenne*	59;4	14;1
RAO 28	*Geranium molle*	43;4	13;5
RAO 3	*Fumaria officinalis*	0	–

[1] Disease index: The first number gives the percentage of damaged sprouts; the second number denotes the average damage to these sprouts rated from: 0 = healthy up to 5 = maximally damaged or dead. – = not determined.

Tabel 2. Rhizotonia-isolaten afkomstig van verschillende onkruiden en hun pathogeniteit t.o.v. aardappelkiemen in perliet en in vermiculiet.

through which *Rhizoctonia* could enter the sprout. A soft material as vermiculite used under the same experimental conditions, often allowed the growth of stolons with a lower disease index, and consequently will be used for these tests.

Although saprophytic strains of *R. solani* do not damage the potato plants, they do substantially lower the quality and value of seed potatoes by forming many sclerotia on the tubers (Jager and Velvis, 1980). In this respect they are just as harmful as pathogenic strains.

Thus it is important to keep arable fields free from weeds, not only because weeds compete with the crop for nutrients, water, light or space, but also because some of them contribute to the survival and spread of *Rhizoctonia* spp.

The results of this study are related only to the fields examined and have in general, a more on less qualitative character: weeds contribute to the survival of *R. solani.*

Samenvatting

Het voorkomen van Rhizoctonia solani op ondergrondse delen van wilde planten (onkruiden) in aardappelakkers

Wortels, wortelstokken en ondergrondse stengeldelen van onkruiden voorkomend in aardappelakkers in Groningen, Friesland en Drenthe zijn onderzocht op de aanwezigheid van *Rhizoctonia solani.* Van 1585 planten, behorend tot 52 soorten, herbergde bijna 2%, d.w.z. 29 planten behorend tot 12 soorten, *R. solani* op de ondergrondse delen. Van deze *Rhizoctonia*-isolaten bleek 62% aardappelspruiten aan te tasten.

Bepaalde onkruidsoorten bleken vaker drager te zijn van *R. solani* dan andere. Dit was het geval met kweek, zwarte nachtschade en echte kamille. Op enkele algemene onkruiden als witte ganzevoet en straatgras is geen *Rhizoctonia* waargenomen. Van het algemeen op zandgronden voorkomende perzikkruid bleek ongeveer 1% *Rhizoctonia* op de wortels te herbergen.

Typische ziektesymptomen – scherpe oogvlekken – zijn alleen waargenomen op stengels van kweek. Het voorkomen van *R. solani* op onkruiden neemt sterk toe tegen het eind van het groeiseizoen (eind augustus en september).

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Book review

A.J. van der Plaats-Niterink, 1981. Monograph of the genus *Pythium*. Studies in Mycology No. 21, Centraalbureau voor Schimmelcultures, Baarn, 244 pp. ISSN 0166-0616. Price Dfl. 70,—

The genus *Pythium* is one of the widespread genera of fungi, the species of which can be found all over the world on diseased or decayed plant material as well as in soil and in water. New species are continuously described. A revision of the genus from time to time is therefore necessary.

The new monograph by Mrs Van der Plaats will be heartily welcomed by everyone working with *Pythium* spp. The great advantage of this book is that a key for identification, descriptions of the species and data about occurrence and pathogenicity as well as a comprehensive literature list are brought together in one book. Up to now at least three publications had to be consulted to get sufficient information about a certain species.

The monograph starts with short chapters on culturing *Pythium* species, morphology and terminology, ecology, pathogenicity and microbial interactions. After a description of the genus *Pythium* follows the key to the species. As far as one is able to judge a key after using it for a short time, it seems that one who has some experience with this genus, can identify the species without too much troubles.

The main part of the monograph consists of the descriptions of the species. Eighty-five species are recognized and described in alphabetical order, and two highly specialized cellulolytic species are treated in an appendix. The descriptions are the result of a thorough study of many isolates, obtained from other investigators and institutes or isolated by the author. Where living material was available, the descriptions were made by the author, if possible based on the type cultures. Where no cultures were available the original description is followed. All species are illustrated by line drawings, often by the author herself; in other cases they are reproduced or redrawn from the original descriptions. A few light micrographs and scanning electron micrographs are added. For each species the taxonomic relation to other species is discussed and a compilation of literature data on occurrence and pathogenicity is given. The list of references contains 1133 publications.

A last chapter is devoted to doubtful and excluded species, altogether sixty five taxa, many of which are incompletely described.

I think that the publication of this monograph is a dignified conclusion of many years dedicated to the study of the Oomycetes. And I am sure that this book will be a valuable completion for all those being engaged in the study of *Pythium* species.

Ida Blok