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NEMATODE DAMAGE AND "SPECIFIC SICKNESS" IN *ROSA, MALUS* AND *LABURNUM*[1]

Met een samenvatting:
Schade door aaltjes en „specifieke moeheid" bij Rosa, Malus *en* Laburnum

BY

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Introduction

There appear to be at least two independent components of the soil-sickness problem of woody crops. Thus, field experiments in 1955 (Oostenbrink, 1956) demonstrated both root damage by *Pratylenchus penetrans* (Cobb) and a further, unidentified, "specific sickness" in rose seedlings, *Rosa canina* L., and apple trees, *Malus pumila* Mill. The term specific sickness refers to unexplained poor growth which appears to be host-specific, i.e. associated only with monoculture of one plant species. Further investigations on the same sites in 1956 and additional experiments and observations clarified the two components and suggested the cause of specific sickness in a number of crops.

Experiments and observations

1. Rosa canina *in field experiments 1956*

In 1953 and 1954 eleven crops were grown in plots in each of two fields W and N. Replication was threefold. The soil in each field was a peaty sand and contained a population of *Pratylenchus penetrans* and other root-infesting nematodes. In 1955 four test crops (roses from seed, young apple trees undersown with red clover, potato and rye) were grown across all plots. Their growth was correlated with the density of the *Pratylenchus* populations; rye, oats and potato were revealed as efficient hosts of *P. penetrans*; these crops were, therefore, unsuitable to precede rose and apple on this soil. In the trial field N only, the extent of disease in *Rosa* and *Malus* could not be attributed entirely to *Pratylenchus* as it was augmented by a specific sickness. This occurred only after two years' continuous growth of one crop; it was not found in apple after two years of roses or in rose after two years of apple. The symptoms were poor growth and, in the case of roses, death of some of the plants. The other test crops, potato and rye, did not reveal any symptoms of specific sickness (Oostenbrink, 1956).

In 1956 both fields were sown with roses. The adverse effects of the potato and cereals crops of 1953 and 1954 were less marked than they were in 1955 but probably still reflected the different eelworm densities produced by the crops of 1953 and 1954. In those parts of trial field N where roses had grown in succession for four years specific sickness was apparent; it was not found in field W.

These results were confirmed by the effects of the crops of 1955 on the rose

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FIG. 1. Influence of four different treatments on a sickness syndrome in rose, *Rosa canina* L. (Soil A recorded in table 2). From left to right: untreated, DD, heated 60°C, Nabam. Treatment in the spring of 1956, roses sown on 11 June, picture taken at the end of August 1956.
Invloed van vier verschillende behandelingen op een moeheidscomplex in roos, Rosa canina L. *(Grond A van tabel 2). Van links naar rechts: onbehandeld, DD, verwarmd 60°C, Nabam. Behandeling voorjaar 1956, roos gezaaid 11 juni, foto genomen eind augustus 1956.*

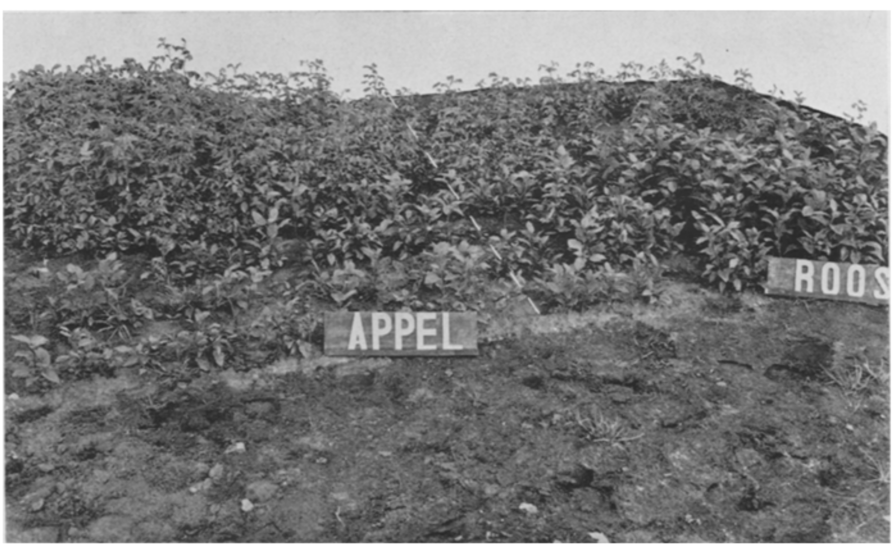

FIG. 2. Specific sickness in two woody crops on the same soil in 1958; picture taken on 31 July 1958. In the background rose, *Rosa canina* L., and in the foreground apple, *Malus pumila* Mill., both following rose (at right) and apple (at left) of the year 1957. The nematode population was reduced by a soil treatment in the autumn of 1956 and can not account for these growth differences (cf. page 268).
Specifieke moeheid bij twee houtige gewassen op dezelfde grond in 1958; foto genomen 31 juli 1958. Op de achtergrond roos, Rosa canina *L., en op de voorgrond appel,* Malus pumila *Mill., beide na roos (rechts) en na appel (links) in het jaar 1957. De aaltjespopulatie was grotendeels gedood door een grondbehandeling in de herfst van 1956 en kan voor deze groeiverschillen niet verantwoordelijk zijn (zie blz. 268).*

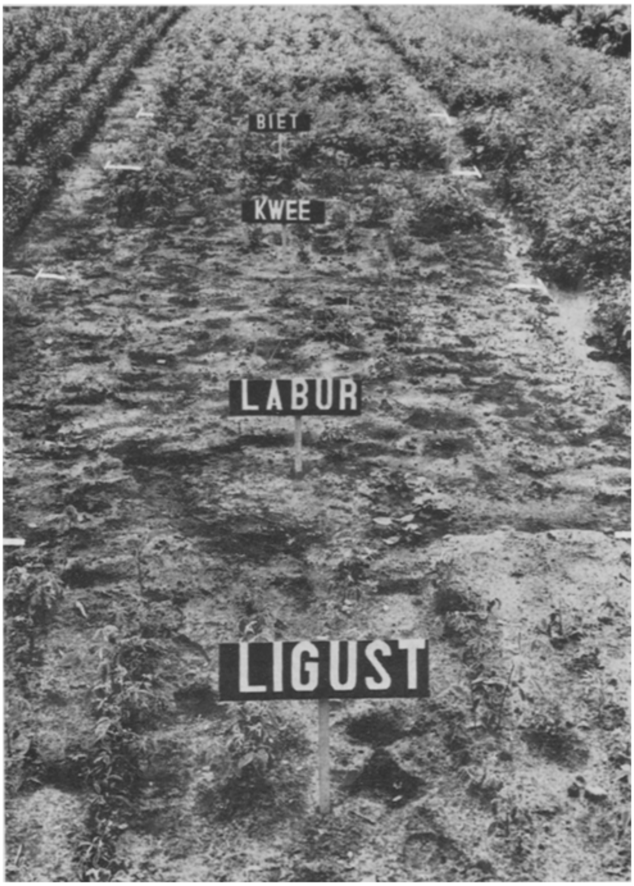

FIG. 3. *Laburnum anagyroides* in 1958, following *Ligustrum ovalifolium* Hassk., *Laburnum anagyroides* Med., *Cydonia oblonga* Mill. (quince), *Beta vulgaris* L. (beet) and other crops. Striking symptoms of specific sickness on the monoculture plot probably caused by "soil-borne" infection of the fungus *Ceratophorum setosum* Kirchn. The infestation spread into the quince plot. The picture was taken on 11 August 1958.
Laburnum anagyroides *in 1958, na* Ligustrum ovalifolium *Hassk.*, Laburnum anagyroides *Med.*, Cydonia oblonga *Mill.* (kwee), Beta vulgaris *L., (biet) en andere gewassen. Opvallende verschijnselen van specifieke moeheid op het monocultuur-veldje, waarschijnlijk veroorzaakt door een door de grond overgaande, bovengrondse aantasting van de schimmel* Ceratophorum setosum *Kirchn. De aantasting verspreidde zich ook in het kweeveldje. Foto 11 augustus 1958.*

crop in 1956 (table 1). Thus, in field W, there is a negative correlation between the density of the *Pratylenchus* population and the yield of rose trees; a preceding crop of rose trees seems to enhance the yield. On field N, however, the preceding crop of rose trees seems to limit the yield although the *Pratylenchus* population is relatively low; this is considered to be the result of specific sickness. *Pratylenchus* and specific sickness both may cause poor growth and death of seedlings; surviving plants do not benefit to a noticeable degree here from the "thinning out" which results from the latter.

TABLE 1. Influence of the crops in 1955 on the *Pratylenchus* population and on the damage to the test crop *Rosa canina* in 1956 in two different soils. Number of rose trees on an area of 4 sq. metres; figures are means of 33 replicate plots. Nematode figures nonreplicate.
Invloed van de gewassen in 1955 op de Pratylenchus-*populatie en op de schade aan het toetsgewas* Rosa canina *in 1956 op twee verschillende percelen. Aantal planten per 4m²; gemiddelden van 33 herhalingsveldjes. Aaltjescijfers zonder herhalingen.*

Crops in 1955 *Gewassen*	Trial field W *Proefveld*		Trial field N *Proefveld*	
	Pratylenchus per 100 ml of soil, spring 1956 / Pratylenchus *per 100 ml grond, voorjaar 1956*	Rose trees 1956, all sizes included. Between brackets rose trees with stem diameter > 3mm / *Totaal aantal rozeplanten 1956. Tussen haakjes de planten met stamdiameter groter dan 3 mm*	*Pratylenchus* per 100 ml of soil, spring 1956 / Pratylenchus *per 100 ml grond, voorjaar 1956*	Rose trees 1956, all sizes included. Between brackets rose trees with stem diameter > 3 mm / *Totaal aantal rozeplanten 1956. Tussen haakjes de planten met stamdiameter groter dan 3 mm*
Rosa canina	225	822 (524)	100	500 (342)
Malus pumila + red clover	360	743 (461)	425	630 (425)
Solanum tuberosum	385	654 (431)	295	628 (402)
Secale cereale	910	592 (383)	313	575 (368)
Least significant difference *Kleinste significante verschil*				
95%		65 (16)		46 (29)
99%		97 (24)		70 (44)
F-value[1] / *F-waarde*[1]		19,3++ (111,6++)		13,8++ (12,6++)

[1] Variance ratio calculated without transformation; ++ = differences significant at 99%.
Variantie-verhouding berekend zonder transformatie; ++ = *verschillen significant bij het 99%-punt.*

2. Rosa canina *in pot experiments 1956–'59*

a. In spring 1956 soil ("rose-soil") was collected from those plots of field N on which rose trees had grown in the years 1953–55 inc. and which in 1955 showed specific sickness. The soil was put into 10-litre pots and received one of the following treatments: 1, control (untreated), 2, "DD" (dichloropropene-dichloropropane) at a rate of 3 ml per 10 litres of soil, 3, heated 60°C for 2 hrs, 4, Nabam (sodium ethylene bisdithiocarbamate) at a rate of 1 litre of 1% Nabam per 10 litres of soil. Replication was threefold. After treatment each pot was sown with *Rosa canina*. A similar sample of soil, which showed no specific sickness in 1955, was taken from those plots on field N which had the cropping sequence rye-rye-rose 1955 ("rye soil") and was treated in the same way. The design of the experiment and its results are shown in fig. 1 and table 2. It appears that the "rye soil" contained more *Pratylenchus* and, in particular, more *P. penetrans* than the "rose soil". DD almost eradicated the nematodes and improved growth more in the "rye soil" than in the "rose soil", but it removed little of the total sickness syndrome. Nabam has less nematicidal effect than DD (in field experiments the dose of Nabam used in these experiments is ineffective), but it better improved the plant growth in the "rose soil". Only heat treatment removed the sickness completely and permitted a good crop. It is suggested that both soils harboured two types of sickness, one caused by eelworms and controlled by DD, and a second (the specific sickness described above in experiment 1) which is controlled by Nabam. Heat treatment controls both sicknesses.

TABLE 2. Influence of four different treatments on *Pratylenchus* damage and specific sickness in *Rosa canina* during the observation period 1956–1959; 10-litre pots, three-replicate.
A. Soil ("rose soil") from the original rose plots of trial field N, with rose in 1953, 1954 and 1955.
B. Soil ("rye soil") from the original rye plots of trial field N, with rye in 1953 and 1954 and a rose crop in 1955.

Invloed van vier verschillende behandelingen op Pratylenchus-*schade en specifieke moeheid bij* Rosa canina *gedurende de periode 1956–1959; 10-liter potten, drievoud.*
A. *Grond van de oorspronkelijke rozeveldjes van proefveld N, met roos in 1953, 1954 en 1955.*
B. *Grond van de oorspronkelijke roggeveldjes van proefveld N, met rogge in 1953, 1954 en 1955.*

Treatments, spring 1956 *Behandelingen voorjaar 1956*	*Pratylenchus* per 100 ml of soil after treatment, spring 1956 Pratylenchus *per 100 ml grond na de behandeling, voorjaar 1956*	Growth evaluation of rose crop 1956-1959; high figure means good crop, august 1956 *Standcijfer van het gewas roos 1956-1959; hoog cijfer betekent goed gewas, augustus 1956*	Weight in g of rose roots per pot, spring 1959 *Gewicht in g van de rozewortels per pot, voorjaar 1959*	*Pratylenchus* extracted from rose roots per pot, spring 1959 Pratylenchus *uit de rozewortels per pot, voorjaar 1959*
A. "Rose soil". Preceding crops rose-rose-rose / *Voorgaande gewassen roos-roos-roos*				
Untreated *Onbehandeld*	30	2.3	261	23750
DD	0	2.7	250	500
Heated 60°C *Verwarmd*	0	9.0	562	1690
Nabam	not determined *niet bepaald*	5.3	317	5070
B. "Rye soil". Preceding crops rye-rye-rose / *Voorgaande gewassen rogge-rogge-roos*				
Untreated *Onbehandeld*	450[1]	1.3	255	23870
DD	0	3.7	307	460
Heated 60°C *Verwarmd*	0	8.7	463	930
Nabam	not determined *niet bepaald*	3.7	288	20590

[1] Of which at least 150 *P. penetrans*. / *Waarvan tenminste 150* P. penetrans.

b. In 1956 "rye soil" and "rose soil" (as above) were set up in pots in an other experiment with different rotations. The treatments were rye, potato, apple and two sets of controls (fallow). Replication was threefold. In spring 1957 one set of fallow pots was heated to 60°C, the nematode populations were estimated and a test crop of *Rosa canina* was sown. In all except the heat-treated soil growth was poor; there was no significant difference between the "rye soil" and the "rose soil" in spite of their different eelworm populations. Growth in unheated fallow pots was less than half of that of the heated fallow soil, in spite of the low number of *Pratylenchus.* Thus only heat treatment is effective in removing the sickness syndrome; cultivation of different crops and fallow for one year did not remove it.

TABLE 3. Influence of preceding crops on specific sickness in sown rose, *Rosa canina* L., and in sown apple, *Malus pumila* Mill., in field experiment N in the years 1958 and 1959. *Invloed van voorgaande gewassen op de specifieke moeheid in rozezaailingen,* Rosa canina *L., en in appelzaailingen,* Malus pumila *Mill., in veldproef N in de jaren 1958 en 1959.*

Preceding crop(s) *Voorgaand(e) gewas(sen)*	Root-infesting nematodes per 100 ml of soil in spring. Between brackets *Pratylenchus* only *Wortelaaltjes per 100 ml grond in het voorjaar. Tussen haakjes alleen* Pratylenchus		Yield rose crop *Opbrengst van roos*		Yield apple crop *Opbrengst van appel*	
			Plants *Planten* per 1 m²	Weight *Gewicht* g/plant	Plants *Planten* per 1 m²	Weight *Gewicht* g/plant
1	2		3	4	5	6
A. Year 1958/*Jaar 1958*						
Rose	315	(38)	85	13.7	89	13.2
Apple	189	(34)	179	14.4	86	8.8
L.S.D.[1] 95%	77	(15)	9.8	1.57	11.4	1.79
99%	115	(22)	14.7	2.36	17.1	2.69
F-value[2]	10.9+	(0.26–)	367.9++	0.67–	0.24–	23.7++
B. Year 1959/*Jaar 1959*						
Rose – Rose	354	(64)	67	9.1	133	7.3
Rose – Apple	307	(42)	90	10.2	96	7.3
Apple – Rose	339	(85)	100	11.1	120	6.6
Apple – Apple	273	(64)	184	11.5	109	6.3
L.S.D.[1] 95%	74	(54)	26.7	0.34	18.3	1.00
99%	111	(81)	40.0	0.51	27.5	1.50
F-value[2]	1.96	(0.85–)	29.1++	84.2++	6.06++	1.86–

[1] Least significant difference at 99% or 95% level is 3 $\sqrt{2}$ or 2 $\sqrt{2}$ times the mean error respectively.

[1] *Kleinste significante verschil bij het 99%- of 95%-punt is 3 $\sqrt{2}$ of 2 $\sqrt{2}$ keer de middelbare fout.*

[2] Variance ratio; ++ = differences significant at 99% level; + = at 95% level; – = non significant.

[2] *Variantie-verhouding*; ++ = *verschillen significant bij het 99%-punt*; + = *bij het 95%-punt*; – = *niet significant.*

3. Rosa canina *and* Malus pumila *in field experiments 1956–'59*

A site adjacent to trial field N was selected for fumigation experiments in 1956. The plot was infested with *P. penetrans* and other root-infesting nematodes and was considered to be "potentially infested" with specific sickness of rose and apple. Eight treatments, each with threefold replication, were applied on plots 6 sq. metres in area; these reduced the eelworm population to between 33% and 6% of the original, the treatments with CPA at 80 ml per sq. metre and at 50 ml per sq. metre being most effective (table 4). Rose seedlings and apple seedlings were each sown in a strip across all the plots in 1957, and both crops showed marked response which could be explained on the basis of nematode kill and phytotoxicity (MEIJNEKE, unpublished).

In 1958 the same crops were again sown on all plots but the strips were sown at right angles to the 1957 strips. Where rose followed rose, or apple followed apple, specific sickness symptoms appeared (fig. 2 and table 3A). The specific sickness was not prevented by any of the chemical treatments (in fact it was aggravated by CPA = chloropicrin-ethylene dibromide mixture, see below) and it could not be correlated with nematode density (table 3, col. 2). Specific sickness in rose is primarily shown by the death of seedlings and to a less extent by the poor growth of the remaining plants (table 3A, col. 3 and col. 4). In apple, it is primarily shown by the reduced weight of the young trees (table 3A, col. 5 and col 6). Monoculture plots of rose and monoculture plots of apple suffered more from and were attacked earlier by downy mildew, *Peronospora sparsa* Berk., and scab, *Venturia inaequalis* (Cooke) Wint., respectively. The spread of visible symptoms by each of these pathogens was restricted to a 30 cm strip between the monoculture and other plots for many weeks.

In 1959 each quarter of one of the three replicate plots of this experiment was halved and each half was sown with either rose or apple. Thus each crop was preceded by one of the following cropping sequences: 1, rose-rose, 2, rose-apple, 3, apple-rose, 4, apple-apple. Little or no specific sickness was shown by the apple seedlings, the differences present being irregular. The rose trees, however, showed specific sickness symptoms, i.e. "seedling blight" (table 3B); the severity of this was correlated with the number of preceding rose crops. Mycological examination revealed oospores in the stem foot of infested plants. Samples showed that the number of infested plants and the number of oospores on them was consistently less in those roses which followed two apple-tree crops; these roses grew better. The fungus appears to be a Phycomycete and could not be cultured in different artificial media. Monoculture plots of rose suffered again more from early leaf attack by *Peronospora sparsa* than the other plots and this fungus could perhaps be the forementioned Phycomycete.

Table 4 analyses the complete sickness syndrome, demonstrates the separate effects of nematodes and specific sickness and confirms that the different soil treatments of autumn 1956 did not prevent specific sickness in subsequent years. The treatments with CPA, on the contrary, made the specific sickness in rose more severe. This was especially so on the monoculture plots (table 4, col. 3). Surviving plants of both rose and apple are heaviest following CPA, and lightest on untreated plots; this holds for all plots irrespective of their cropping sequence (table 4, col. 4 and col. 6), and is correlated with the nematode density (table 4, col. 2). Apple did not show seedling loss (table 4, col. 5) and an influence of the soil treatments on the specific sickness could not be demonstrated.

TABLE 4. Influence of preceding soil treatments on specific sickness and nematode damage in sown rose, *Rosa canina*, and in sown apple, *Malus pumila*, in field experiment N in the years 1958 and 1959. In 1959 two crop rotation plots in threefold per treatment, in 1959 four crop rotation plots single per treatment. Cf. text and table 3.
Invloed van voorafgaande grondbehandelingen op specifieke moeheid en aaltjesschade bij roos, Rosa canina, *en bij appel,* Malus pumila, *in veldproef N in de jaren 1958 en 1959. In 1958 per behandeling twee rotaties in drievoud, in 1959 per behandeling vier rotaties in enkelvoud. Zie de tekst en tabel 3.*

Soil treatments autumn 1956[1] *Grondbehandelingen najaar 1956*	Root-infesting nematodes per 100 ml of soil in spring. Between brackets *Pratylenchus* only *Wortelaaltjes per 100 ml grond in het voorjaar. Tussen haakjes alleen* Pratylenchus	Yield of rose crop. Between brackets for the monoculture rose plots only *Opbrengst van roos. Tussen haakjes alleen voor de monocultuurveldjes*		Yield of apple crop *Opbrengst van appel*	
		Plants *Planten* per 1 m²	Weight *Gewicht* g/plant	Plants *Planten* per 1 m²	Weight *Gewicht* g/plant
1	2	3	4	5	6
A. Year 1958 (second year after soil treatment)/ ***Jaar 1958 (tweede jaar na de grondontsmetting)***					
N 521 33 g/m²	278 (30)	153 (99)	13.4 (13.3)	96	10.0
N 521 22 g/m²	220 (25)	136 (80)	13.9 (14.0)	89	10.1
CPA 80 ml/m²	*33* (20)	*90 (28)*	*18.9 (19.8)*	85	*15.1*
CPA 50 ml/m²	*45* (15)	*105 (52)*	*16.3 (15.5)*	85	*14.0*
Vapam 100 ml/m²	238 (23)	154 (125)	12.6 (11.1)	90	10.9
Vapam 80 ml/m²	247 (25)	141 (98)	13.8 (14.3)	85	9.5
DD 60 ml/m²	240 (40)	124 (83)	12.7 (11.7)	86	10.9
Untreated/*Onbehandeld*	*715 (108)*	*154 (115)*	*10.8 (10.2)*	83	*7.6*
L.S.D.[2] 95%	153 (29)	19.6	3.15	22.8	3.59
99%	230 (44)	29.4	4.72	34.2	5.38
F-value[3]	15.0^{++} (8.3^{++})	12.1^{++}	5.03^{++}	0.27–	3.71^{++}
B. Year 1959 (third year after soil treatment) / ***Jaar 1959 (derde jaar na de grondontsmetting)***					
N 521 33 g/m²	155 (15)	111 (97)	10.1 (6.9)	119	6.5
N 521 22 g/m²	225 (45)	123 (73)	10.3 (10.9)	140	5.1
CPA 80 ml/m²	*35* (35)	*107 (41)*	*10.8 (11.5)*	115	*8.8*
CPA 50 ml/m²	*70* (40)	*96 (48)*	*11.2* (10.4)	112	*9.7*
Vapam 100 ml/m²	175 (30)	111 (68)	10.0 (8.3)	112	6.2
Vapam 80 ml/m²	260 (40)	111 (60)	12.6 (10.9)	103	7.7
DD 60 ml/m²	190 (10)	113 (56)	9.6 (8.3)	123	7.4
Untreated/*Onbehandeld*	*705 (175)*	*113 (89)*	*9.2 (5.2)*	97	*3.6*
L.S.D.[2] 95%	64 (47)	37.7	0.48	25.9	1.42
99%	96 (70)	56.5	0.71	38.8	2.13
F-value[3]	162.2^{++} (6.57^{++})	0.31–	39.8^{++}	2.01–	15.3^{++}

[1] N 521 = 3,5 – dimethyl – tetrahydro – 1, 3, 5, 2 H – thiadiazine – 2 – thione; CPA = chloropicrin 90% + ethylenedibromide 10%; Vapam = sodium N-methyldithiocarbamate dihydrate; DD = dichloropropene + dichloropropane.

[2] Least significant difference at 99 or 95% level is $3\sqrt{2}$ or $2\sqrt{2}$ times the mean error respectively.

[2] *Kleinste significante verschil bij het 99%- of 95%-punt is $3\sqrt{2}$ of $2\sqrt{2}$ keer de middelbare fout.*

[3] Variance ratio; $^{++}$ = differences significant at 99% level; $^{+}$ = at 95% level; – non significant.

[3] *Variantie-verhouding; $^{++}$ = verschillen significant bij het 99%-punt; $^{+}$ = bij het 95%-punt; – = niet significant.*

4. Laburnum anagyroides *in rotation experiment NW*

In another field experiment in 1956 seedlings of *L. anagyroides* Med. and eleven other crops were grown in long strips. In 1957 the same crops were again grown in strips but at right angles to the 1956 strips and the cropping was repeated with a 90° change of strip direction each year in the three following years. Replication was threefold. At first the crops were healthy but disease eventually appeared in some crops, amongst other a specific sickness in *Laburnum*.

The *Laburnum* crop, which was uniform and healthy in 1956, gradually deteriorated due to an outbreak of the fungus *Ceratophorum setosum* Kirchn. In 1958 damage was serious in the monoculture plots following an early attack by *C. setosum* (fig. 3). A further outbreak of the disease in July 1958 spread downwind into adjacent plots with other rotations and the spread could not be controlled by fungicidal sprays; the crop on the monoculture plots failed completely. The disease outbreak and spread followed the same pattern in 1959 and 1960, though the infestation was not so severe.

P. penetrans was present with other root-infesting nematodes in the plots and although *Laburnum* is an efficient and susceptible host of this species, the population of *P. penetrans* was low throughout the experiment in all plots. It is concluded that *P. penetrans*, or other eelworms, were not responsible for the specific sickness symptoms.

Discussion and conclusion

Pratylenchus penetrans has already been established as damaging to *Rosa, Malus* and *Laburnum* (Oostenbrink, 1955; Oostenbrink, s'Jacob & Kuiper, 1957). The results of the present investigations confirm that previous cultivation of rye and potatoes (efficient hosts of *P. penetrans)* can increase *Pratylenchus* damage to *Rosa* and *Malus* (table 1). This damage, therefore, is not a specific sickness as defined earlier in this paper. *Pratylenchus* damage can be controlled by treating soil with nematicides and the level of this damage is correlated with nematode density (table 4). Heavy nematode infestation can cause poor growth and also significant loss of rose seedlings (table 1).

Parasitic fungi are now believed to be the cause of specific sickness which was noticed together with nematode infestations in 1955, at least in some crops (Oostenbrink, 1956). The disease of *Laburnum anagyroides* described in this paper is an example of this. Here infestation of leaves and stems of young plants by *Ceratophorum setosum* is probably the pathogen; nematodes are not involved and no other agent can be found. Experiments with rose trees in field N in 1956 confirmed earlier findings that specific sickness and nematode damage may occur together. The pot experiments (2a and 2b above) show that specific sickness can follow one crop of rose trees and that it is not removed by a year's alternative cropping or by fallow. Nabam (a fungicide) controls specific sickness (fig. 2, table 2) but DD does not. The disease is first recognised as seedling blight which appears after rose monoculture, the close association between the sickness symptoms and the number of fungal oospores indicate that the soil is probably infected by a Phycomycete. Field observations indicate, that this could be *Peronospora sparsa*, but no certainty can be given until experimental evidence becomes available. There is, however, little doubt that specific sickness in roses is due to a fungus. The causal agent of specific sickness on apple has still to be found. The field experiments 1956–'59 suggest that scab, caused by *Venturia inaequalis*, could have played a role in this case.

Specific sickness, as described above for *Rosa*, *Malus* and *Laburnum*, did not occur in other crops on the trial fields and it cannot therefore be considered common to all monoculture crops. The symptoms appeared after different cropping times in different fields, some fields showing no symptoms after four successive crops of rose or apple. Specific sickness and nematode damage are not related; in tree nurseries where crop rotation is practised, nematode damage may be important while specific sickness is probably not (MEIJNEKE, 1959), but in replanted orchards specific sickness may be an important component of the sickness syndrome.

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SAMENVATTING

Aansluitend bij vorige proeven over moeheidsverschijnselen bij boomkwekerijgewassen werden de aantasting door *Pratylenchus penetrans* en de verschijnselen van specifieke moeheid (zie blz. 264), in het bijzonder bij *Rosa*, *Malus* en *Laburnum* nader onderzocht.

P. penetrans kan alle genoemde gewassen aantasten en schaden. De aantasting is niet specifiek en wordt verergerd door de voorafgaande teelt van rogge en aardappel (tabel 1). Grondontsmetting met nematiciden kan deze schade voor verscheidene jaren opheffen (tabel 4). Deze gegevens waren uit vroeger onderzoek reeds bekend. Bij *Rosa canina* blijkt deze aantasting, behalve slechte groei, ook het wegvallen van zaailingen te kunnen veroorzaken (tabel 1).

De specifieke moeheid van de onderzochte gewassen blijkt vaak samen met aaltjesaantasting op te treden, maar houdt daarmee geen verband. Bij monocultuur van *Laburnum anagyroides* trad in het tweede en derde gewas een specifieke moeheid op, waarschijnlijk veroorzaakt door een door de grond overgaande aantasting van blad en stengel van de jonge planten door *Ceratophorum setosum* (fig. 3). De specifieke moeheid in *Rosa canina* veroorzaakte in de eerste plaats wegvallen van jonge planten en later bij de overblijvende planten een slechte groei (tabel 3). Bij behandeling van besmette grond werd met het schimmelmiddel Nabam een veel beter effect verkregen dan met het aaltjes-middel DD (fig. 1, tabel 2). In de stengelvoet van aangetaste planten werden regelmatig oösporen gevonden van een Phycomyceet, die nog niet gedetermineerd kon worden. Veldwaarnemingen wijzen er op, dat het mogelijk een door de grond overgaande aantasting van valse meeldauw, *Peronospora sparsa*, betreft.

De specifieke moeheid bij *Malus pumila* is vroeger vermeld van jonge boompjes (proefveld N in 1955, zie blz. 264), maar betreft hier zaailingen. Zij trad op in dezelfde percelen waar ook *Rosa* specifieke moeheid vertoonde (fig. 2, tabel 3A), maar uitte zich alleen in slechte groei van de planten en niet in het wegvallen van jonge planten. Zij kan in het tweede opeenvolgende gewas *Malus* reeds optreden. De oorzaak is niet nader aan te geven. Bij de in fig. 2 weergegeven proef ging de slechte groei samen met een sterke aantasting van de jonge plantjes door schurft, *Venturia inaequalis*, maar uit nader onderzoek zal nog moeten blijken of dit als oorzaak of als gevolg van de specifieke moeheid moet worden beschouwd.

De genoemde symptomen van specifieke moeheid traden lokaal op. Alle drie traden op bepaalde percelen in het tweede of derde gewas op, maar op andere percelen waren in het vierde gewas *Rosa* of *Malus* nog geen symptomen zichtbaar. Bij *Laburnum* en *Rosa* worden ze vrijwel zeker, bij *Malus* mogelijk veroorzaakt door een specifieke, door de grond overgaande parasitaire schimmel. Dergelijke verschijnselen kunnen bij meer gewassen voorkomen. Zij traden in deze proeven evenwel niet op bij verscheidene andere land- en tuinbouwgewassen en zijn niet inherent aan eenzijdige teelt.

De betekenis van de voorgenoemde verschijnselen van specifieke moeheid is in de boomkwekerijen, waar wisseling van de gewassen regel is, waarschijnlijk klein vergeleken met de aaltjesschade. Er zijn aanwijzingen, dat bij herbeplanting van boomgaarden een dergelijk complex van aaltjesschade en specifieke moeheid voorkomt en dat de specifieke verschijnselen daar belangrijker zijn dan in kwekerijen.

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