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The influence of continuous cropping and free-living root lesion nematodes on yield of fodder maize

K. SCHOLTE[1] and J.J. s' JACOB[2]

[1] Department of Field Crops and Grassland Science, Agricultural University, Haarweg 333, 6709 RZ Wageningen, the Netherlands
[2] Department of Nematology, Agricultural University, P.O. Box 8123, 6700 ES Wageningen, the Netherlands

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Abstract

In field and pot experiments it was investigated, whether continuous cropping of maize causes yield decrease. Although the experiments have not yet enough advanced to provide all answers, there are indications that allowance has to be made for yield losses. Under continuous cropping root rot occurs in an early stage of growth. The application of the nematicide oxamyl gave an excellent control on the root lesion nematodes *Pratylenchus* spp. and strongly stimulated the initial growth of maize, but it had not or hardly any positive effect on the yield. The application of oxamyl did not influence the occurrence of root rot.

Additional keywords: Pratylenchus, Tylenchorhynchus, oxamyl, nematicide.

Introduction

During the seventies the area under fodder maize was extended spectacularly in the Netherlands. The crop is mainly grown on farms which do not produce other arable crops, and therefore maize is often grown on the same fields year after year. This continuous cropping may lead to yield losses because of increasing densities of nematodes and other pathogens. In field and pot experiments we have tried to quantify these effects. This paper presents preliminary results of our experiments.

Materials and methods

Experiment 1 (field trial 1976-1978). In 1978 the effects of four crop sequences were compared, viz.

a. maize - maize - maize
b. potato - maize - maize
c. maize - potato - maize
d. potato - potato - maize

All four crop sequences included untreated plots and plots treated with the systemic nematicide oxamyl, which was applied and incorporated into the soil in a dose of 50

kg Vydate 10G (10% a.i.) per ha at sowing time (April 26). On June 1 and 20 the treatment was repeated as a leaf spray (1.2 l Vydate L (24% a.i.) per hectare). No manure was given during the trial. The maize cultivar Fronica was used. The soil was a light sandy soil containing 2.4% organic matter.

Experiment 2 (pot trial 1979). This experiment was carried out with the same type of soil as experiment 1. Two crop sequences were compared:
maize - rye - potato - rye - maize (= maize 1:4) and
barley - maize - maize - maize - maize (= maize 1:1)
The investigation included untreated batches of pots, and batches treated with oxamyl, applied in a dose of 0.02 ml Vydate L/l soil four times from sowing on and at intervals of 3 weeks. The experiment was carried out in conditioned greenhouses with two day/night temperature regimes, viz. 18/12 °C and 24/18 °C and under natural light conditions from 2nd April to 28th September. The maize cultivar LG11 was used.

Experiment 3. (This rotation experiment started in 1979 and will be continued until 1987. The results of 1979 and 1980 are already included in this paper). The experiment was laid out in 1979 on light sandy soil containing 2.6% organic matter. Continuous cropping of maize is compared with rotation systems of 1:2 and 1:5. The plots are untreated or treated yearly with oxamyl at a dose of 50 kg Vydate 10G/ha just before sowing. The maize cultivar used is Fronica.

In experiment 1 chemical analyses were done per plot. Subsamples were analysed after digestion in sulphuric acid and hydrogen peroxide. Potassium was determined with a flamephotometer and phosphate and nitrogen were measured with a colorimeter.

Extraction of endoparasitic nematodes from the roots was done by the funnel-spray method (extraction time six days). Determination of nematode densities in soil was done by extracting the nematodes from the soil with the Oostenbrink elutriator.

Results

Experiment 1 (field experiment 1976-1978). In November 1977, the nematode densities were determined on the basis of soil samples (Table 1). The most common nematodes were *Pratylenchus* spp., *Tylenchorhynchus dubius* and *Meloidogyne hapla.* With the crop sequence of maize – maize the *Pratylenchus* population consisted of about 50% *P. crenatus* and about 50% *P. fallax,* whereas in the sequence of potato – potato only *P. crenatus* was present. The population of both *Pratylenchus* and *Tylenchorhynchus* increased with an increasing frequency of maize cropping. The *Meloidogyne* population responded in the opposite way, as expected, because maize suppresses this population.

On 17 July 1978, in the middle of the growing season, root and soil samples were taken from the maize plots to determine the nematode densities (Table 2). Oxamyl reduced the population density of *Pratylenchus* in the roots by 93% on average. Reduction in the soil was less conspicious, viz. 66% for *Pratylenchus* and 82% for *Tylenchorhynchus.* The densities strongly depended on the crop sequence. Numbers of over 20 000 *Pratylenchus* per 10 g of roots, as found in this experiment for three or two successive maize croppings, must be regarded as very high scores.

Table 1. Numbers of nematodes per 100 ml soil (November 1977) in various crop sequences. (Experiment 1).

Crop sequence		*Pratylenchus*	*Tylenchorhynchus*	*Meloidogyne*
1976	1977			
maize	- maize	773	391	0
potato	- maize	436	391	17
maize	- potato	355	99	40
potato	- potato	147	67	185

Tabel 1. Aantal nematoden per 100 ml grond (november 1977) in verschillende vruchtopvolgingen. (Experiment 1).

Table 2. Numbers of nematodes on 17 July in various crop sequences and in untreated (—) and oxamyl-treated (+) plots. (Experiment 1).

Crop sequence			*Pratylenchus*/ 10 g root		*Pratylenchus*/ 100 ml soil		*Tylenchorhynchus*/ 100 ml soil	
1976	1977	1978	—	+	—	+	—	+
maize	- maize -	maize	29 000	2 100	533	227	513	73
potato	- maize -	maize	20 000	1 400	677	187	583	123
maize	- potato-	maize	6 700	400	163	53	163	37
potato	- potato-	maize	7 000	300	110	40	117	10

Tabel 2. Aantal nematoden op 17 juli bij verschillende vruchtopvolgingen en bij onbehandelde (—) en met oxamyl behandelde (+) veldjes. (Experiment 1).

During the growing season the length of the plants was measured at various dates (Table 3). Application of oxamyl initially increased plant length for all crop sequences. After that time no difference was observed between treated and untreated plots. Neither the ultimate yield of dry matter nor the uptake of minerals was influenced positively by oxamyl (Table 4).

The shortest plants were found with three successive croppings of maize, whereas the tallest plants were observed with two successive croppings of potato followed by one maize cropping. In the initial stage of growth no differences in plant length between crop sequences were observed. These appeared at a later stage. The lowest yield of dry matter and uptake of minerals were found with three successive maize croppings and the highest with the crop sequence: potato - potato - maize. The difference in yield between these two schemes was nearly 10%. The differences in uptake of minerals were greater, especially so for uptake of phosphate and potassium. Visual observations on roots showed that under continuous cropping more root rot occurred than with the potato - potato - maize scheme.

Table 3. Plant length in cm at different dates, in various crop sequences and in untreated (—) and oxamyl-treated (+) plots. (Experiment 1).

Crop sequence			2/6			19/6			17/7			4/9		
1976	1977	1978	—	+	mean	—	+	mean	—	+	mean	—	+	mean
maize -	maize -	maize	21.0	21.8	21.4a	67.3	70.6	69.0a	133	135	134a	193	191	192a
potato-	maize -	maize	19.9	21.6	20.8a	67.3	71.6	69.4a	135	141	138ab	195	195	195ab
maize -	potato-	maize	20.9	21.3	21.1a	67.7	71.0	69.3a	136	139	138ab	196	191	194ab
potato-	potato-	maize	21.9	22.0	21.9a	69.5	71.0	70.2a	139	143	141 b	200	199	200 b
mean			20.9	21.7		67.9	71.1		136	140		196	194	
			a	b		a	b		a	b		a	a	

[1] Different letters indicate significant differences at P = 0.01 (Studentized range test of Tukey).

Tabel 3. Planthoogte in cm op diverse data, bij verschillende vruchtopvolgingen en bij onbehandelde (—) en met oxamyl behandelde (+) veldjes. (Experiment 1).

Table 4. Dry matter (Dm) production at final harvest and uptake of nitrogen (N), phosphorus (P) and potassium (K) in various crop sequences and in untreated (—) and oxamyl-treated (+) plots. (Experiment 1).

Crop sequence			Dm (t ha^{-1})			N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
1976	1977	1978	—	+	mean	—	+	mean	—	+	mean	—	+	mean
maize -	maize -	maize	11.5	11.5	11.5a	141	143	142a	20.5	19.7	20.1a	80	82	81a
potato-	maize -	maize	12,7	12.3	12.5 b	164	155	160 b	22.4	22.2	22.3ab	100	92	96ab
maize -	potato-	maize	12.0	12.2	12.1ab	154	157	156ab	23.3	22.2	22.7ab	97	89	93ab
potato-	potato-	maize	12.9	12.6	12.7 b	164	159	162 b	24.3	23.5	23.9 b	107	106	106 b
mean			12.2	12.1		156	154		22.6	21.9		96	92	
			a	a		a	a		a	a		a	a	

[1] Different letters indicate significant differences at P = 0.01 (Studentized range test of Tukey).

Experiment 2 (pot experiment, 1979). The density of the initial *Pratylenchus* population was greater under continuous cropping than in the 1:4 scheme (300 and 180 per ml soil, respectively). It was a mixed population consisting of *P. crenatus* and *P. fallax.* Until the middle of the growing season the number of *Pratylenchus* in the roots was greater at both temperature regimes with continuous cropping than with the 1:4 scheme (Tables 5 and 6). At the end of the growing season the population in the 1:4 scheme was definitely as large as the one observed with continuous cropping. In the middle of the growing season more than 90% of the entire *Pratylenchus* population appeared to be concentrated in the roots. At the end of the season this percentage still remained between 60 and 70 (Table 6).

Application of oxamyl suppressed the population of *Pratylenchus* in the roots. Only in the first weeks of the growth period under continuous cropping reasonable numbers of nematodes were found in the roots. The ectoparasitic nematode *T. dubius* showed no difference in initial density of population between continuous cropping and a 1:4 scheme (Table 7).

Initially the development of the populations was equal in both rotation schemes. At a later stage the population in the continuous cropping scheme distinctly fell behind. This decrease started already at a time when the population in the 1:4 scheme was still increasing. The lower rate of multiplication of *Tylenchorhynchus* in continuous cropping was associated with early root degeneration as a result of root rot, which may have been caused by other pathogens. Application of oxamyl sharply reduced the number of *Tylenchorhynchus* in the soil. Oxamyl positively influenced the initial development of plants in both rotation schemes. This resulted in a higher dry matter production (Table 8).

With continuous cropping this positive effect changed later into a negative one. It appeared that with the dose used and under the given experimental conditions oxamyl was phytotoxic. With continuous cropping, in contrast to the 1:4 scheme, the weakened

Table 5. Numbers of *Pratylenchus* spp. per 10 g of roots at different dates, in two crop sequences in untreated (—) and oxamyl-treated (+) soil and at two temperature regimes. (Experiment 2).

18/12 °C					24/18 °C				
day	1:4		continuous		day	1:4		continuous	
	—	+	—	+		—	+	—	+
29	1272	66	6039	552	29	1151	63	9776	347
56	2363	6	9032	35	49	1611	7	5532	31
84	1773	21	4993	5	70	2163	16	5700	70
112	2647	6	4115	7	91	6940	9	7073	50
148	5147	48	3202	10	114	2634	1	4493	2

Tabel 5. Aantal Pratylenchus spp. per 10 g wortel op verschillende data, bij twee vruchtopvolgingen, bij onbehandelde (—) en met oxamyl behandelde (+) grond en bij twee temperatuur regimes. (Experiment 2).

Table 6. Numbers of *Pratylenchus* spp. in 100 ml soil + roots and % of the population present in roots at different days after sowing, in two crop sequences and at two temperature regimes. (Experiment 2).

18/12 °C					24/18 °C				
day	number of *P.*		%		day	number of *P.*		%	
	1:4	continuous	1:4	continuous		1:4	continuous	1:4	continuous
0	180	300	0	0	0	180	300	0	0
29	245	406	5	14	29	209	410	11	43
56	292	983	94	94	49	242	527	75	90
84	441	968	97	90	70	361	718	94	91
112	1208	1103	95	88	91	1551	1211	86	73
148	1748	976	96	65	114	1005	1065	85	72

Tabel 6. Aantal Pratylenchus spp. in 100 ml grond + wortels en het % van de populatie dat zich in de wortels bevond, op verschillende dagen na het zaaien, bij twee vruchtopvolgingen en twee temperatuur regimes. (Experiment 2).

Table 7. Numbers of *Tylenchorhynchus dubius* in 100 ml soil at different days after sowing, in two crop sequences, in untreated (—) and oxamyl-treated (+) soil and with two temperature regimes. (Experiment 2).

18/12 °C					24/18 °C				
day	1:4		continuous		day	1:4		continuous	
	—	+	—	+		—	+	—	+
0	440	440	480	480	0	440	440	480	480
29	458	388	440	215	29	477	197	365	167
56	918	132	915	38	49	1441	53	1115	33
84	2840	45	2618	0	70	3160	31	2033	175
112	3870	3	1902	0	91	3418	0	1710	15
148	3434	3	1975	5	114	1823	0	1245	3

Tabel 7. Aantal Tylenchorhynchus dubius in 100 ml grond op diverse dagen na het zaaien, bij twee vruchtopvolgingen, bij onbehandelde (—) en met oxamyl behandelde (+) grond en bij twee temperatuur regimes. (Experiment 2).

root system was not sufficiently able to recover. The phytotoxicity was greatest at the lower temperature. External damage in aerial plant parts was not observed.

In untreated soil, in the beginning there was no difference in growth rate between the 1:4 rotation scheme and continuous cropping. However, in the middle of the growing season a distinct delay in growth rate set in under continuous cropping. In comparison with the 1:4 scheme this resulted in about 9% loss in yield at the low temperature regime and 6.5% at the high temperature regime. At both temperature regimes more root rot occurred under continuous cropping than with the 1:4 scheme. Application of oxamyl did not have any effect on the occurrence of root rot.

Experiment 3 (field experiment 1979-1980). In 1979, only the effect of oxamyl application could be studied in this experiment, whereas differences caused by crop rotation could only be determined in 1980. In March 1979 the nematode population was examined quantitatively and qualitatively before sowing. The initial density of *Pratylenchus* (mainly *P. crenatus)* was not very high. Moreover, potato and maize in the rotation scheme apparently did not increase the population density (Table 9). The effect of potatoes was as expected. Oats increased the *Pratylenchus* population. The *Pratylenchus* population was reduced in 1979 by application of oxamyl, especially in the scheme with potato.

In 1980 the population appeared to increase under the influence of maize, markedly so where maize was used in the rotation twice. Compared with untreated plots, the use of oxamyl reduced the population on average by 67%.

In 1979 the initial density of the *Tylenchorhynchus* population was high because of rye cropping in the previous year. This high level was maintained in 1979 when maize was grown. It decreased to some extent under oat cultivation. Rotation with potato resulted even in a decrease of 75%.

Table 8. Dry matter yield (g/pot) at different days after sowing, in two crop sequences, in untreated (—) and oxamyl-treated (+) soil and at two temperature regimes. (Experiment 2).

18/12 °C							24/18 °C						
day	1:4			continuous			day	1:4			continuous		
	—	+	mean	—	+	mean		—	+	mean	—	+	mean
29	0.9	1.1*	1.0	0.9	1.1*	1.0	29	4.3	5.2*	4.7	4.3	4.5	4.4
56	17	19	18	20	19	19	49	40	42	41	40	38	39
84	100	93*	97	99	90*	95	70	118	121	120	112	101*	106**
112	232	215	223	197	174*	186**	91	214	216	215	192	166*	179**
148	272	274*	273	247	190*	219**	114	233	233	233	218	174*	196**

* Oxamyl effect significantly different from untreated within the rotation at P = 0.05 (Turkey test).
** Mean of continuous cropping significantly different from means of 1:4 scheme within the temperature regime at P = 0.001 (F-test).

Tabel 8. Droge stof opbrengst (g/pot) op verschillende dagen na het zaaien, bij twee vruchtopvolgingen, bij onbehandelde (—) en met oxamyl behandelde (+) grond en bij twee temperatuur regimes. (Experiment 2).

Table 9. Numbers of *Pratylenchus* spp. and *Tylenchorhynchus dubius* in 100 ml soil in various crop sequences and in untreated (—) and oxamyl-treated (+) plots. (Experiment 3).

Sampling time	Crop sequence	*Pratylenchus* spp.		*Tylenchorhynchus dubius*	
	1978 1979 1980	—	+	—	+
March 1979	rye	335		1000	
November 1979	rye - maize	270	163	955	605
	rye - oats	505	205	725	460
	rye - potato	345	65	225	135
November 1980	rye - maize - maize	1038	378	1126	560
	rye - oats - maize	455	180	865	580
	rye - potato - maize	605	120	700	295

Tabel 9. Aantal Pratylenchus spp. en Tylenchorhynchus dubius per 100 ml grond in verschillende vruchtopvolgingen. (Experiment 3).

The oxamyl treatment reduced the population on average by 37%, as compared with the untreated . In 1980 the *Tylenchorhynchus* population increased in all cases after maize. Especially the low densities after potato showed a sharp increase.In comparison with untreated plots, oxamyl reduced the density by one half.
Both in 1979 and in 1980 oxamyl stimulated the growth of the crop, which expressed itself in a greater plant length (Tables 10 and 11). In general, the greatest stimulus was given at the beginning of the growing season. The absolute figures show that this advantage disappeared to a great extent as the growing season advanced. Oxamyl application ultimately resulted in an increase in dry matter yield of over 4% in 1979 and not quite 2% in 1980 (for both years the differences is not statistically significant at

Table 10. Plant length and dry matter yield in untreated (—) and oxamyl-treated (+) plots. (Experiment 3 - 1979).

Date	—	+	Oxamyl effect (%)
	Plant length (cm):		
26/6	65	69	6.2
27/7	167	174*	4.2
28/8	199	204*	2.5
	Dry matter (t ha^{-1}):		
15/10	12.1	12.6	4.1

* Significantly different from untreated at P = 0.05 (F-test).

Tabel 10. Planthoogte en droge stofopbrengst in onbehandelde (—) en met oxamyl behandelde (+) veldjes. (Experiment 3 - 1979).

Table 11. Plant height and dry matter yield (Dm) in various crop sequences and in untreated (—) and oxamyl-treated (+) plots. (Experiment 3-1980).

Crop sequence			Plant height (cm)										Dm (t ha^{-1})		
1978	1979	1980	12/6			23/6			15/7			3/9			6/10		
			—	+	mean	—	+	mean	—	+	mean	—	+	mean	—	+	mean
rye	- maize	- maize	50	53	51a	87	92	89a	152	161	156a	200	207	203a	10.7	10.9	10.8a
rye	- oats	- maize	50	54	52ab	86	94	90ab	151	162	156a	198	206	202a	11.2	11.5	11.4a
rye	- potato	- maize	53	57	55b	93	97	95b	162	166	164b	207	203	205a	11.2	11.3	11.3a
mean			51	54		89	94		155	163		202	205		11.1	11.3	
			a	b		a	b		a	b		a	a		a	a	
Oxamyl effect (%)			5.9			5.6			5.2			1.5			1.8		

[1] Different letters indicate significant differences at P = 0.05 (Studentized range test of Tukey).

Tabel 11. Planthoogte en droge stofopbrengst (Dm) bij verschillende vruchtopvolgingen en bij onbehandelde (—) en met oxamyl behandelde (+) veldjes. (Experiment 3-1980).

5% level). Two successive crops of maize resulted in c 4.5% loss in yield in 1980, when compared with the oats - maize or potato - maize sequence.

In the maize - maize scheme more root rot occurred than in the schemes with maize following oats of potato.

Discussion

These experiments have shown that maize is a good host to both *P. crenatus* and *T. dubius*. During the growth of the crop the populations of these nematode species increased strongly. It appears that half-way through the growing season over 90% of the *Pratylenchus* population occurred in adventitious roots. These findings agree with those of Maassen (1977). At the end of the season still 60-70% is found in the roots. The rotting of maize roots in autumn is a rather slow process, particularly so with a sound rotation scheme. Assessment of population densities of *Pratylenchus* in the soil early in autumn may therefore give erroneous results. This would explain the unexpectedly low number of *Pratylenchus* in November 1979 after maize in experiment 3. The density of the *Tylenchorhynchus* population corresponded to the expectations. In the November 1980 sampling of the same experiment, it appeared that the population density after maize - maize was twice as high as after oats - maize and potato - maize, an unexpectedly large difference. A possible explanation is that after the maize - maize scheme other soil pathogens infested the root system, which resulted in a faster decay. The difference in rate of decay was perceptible to the naked eye.

In the experiments on a light soil, oxamyl provided good control of both *Pratylenchus* and *Tylenchorhynchus*. In all experiments the crop reacted equally to its application. In the juvenile stage a clearly positive effect was observed, which for a great part disappeared as the growing season advanced. The ultimate increase in yield was very small, viz. 0-5%. The initial growth improvement was as high in presence of few nematodes as for situations with three or four times the number of nematodes. This could be an indication either of exceeding the damage threshold or a positive side-effect of the nematicide on plant development. Maize seems to be particularly sensitive to nematodes during the germination. Once sturdy crown roots have been formed, under normal conditions the crop is able to achieve nearly complete recovery from the initial growth inhibition. However, under long-lasting unfavourable conditions in spring the ultimate loss in yield may be considerable as has been observed by Maassen (1976) in Germany. Notwithstanding a high density of the *P. neglectus* population in favourable weather during spring, he could not find any damage on a field where the year before after a wet and cold spring the initial growth had been inhibited by *P. neglectus* and *Heterodera avenae*. Although maize is not an ideal host to *H. avenae*, yield depressions have been recorded (Behringer, 1975; Maas and Brinkman, 1977).

Our results do not agree with the results obtained by Dern (1977) in Hessen-Nassau. Having applied Temik 10G (aldicarb) or granulate of Curaterr (carbofuran) to the maize crop, he obtained yield increases of 20-34%. Dern, therefore, advised to use nematicides when soil analysis indicates an initial density of 100 *P. penetrans* or 200 *P. neglectus* per 100 ml of soil. This difference in results may be due to the fact that in Hessen-Nassau mainly *P. neglectus* and *P. penetrans* occur, whereas in sandy soils in the Netherlands mainly *P. crenatus* and *P. fallax* are found.

On the basis of our experiments it is as yet impossible to predict whether in the

Netherlands continuous cropping of maize may lead to important decreases in yield. However, there are indications of decreases in yield. It appeared that, in comparison with a 1:4 rotation scheme, the yield after two successive cultivations of maize was reduced by c 5% and after three successive cultivations of maize by c 10%; we did not use liquid manure, which is usual in practice.

In Baden-Würtemberg, Martin (1980) observed that in the course of 10 years of continuous maize cropping two of the three experiments showed a slight tendency to lower yields (3-7%), whereas the third experiment did not show any negative effect at all. In Changins, Switzerland, Vez (1975) did not find any evidence of a lower yield after five years of continuous cropping. In Ontario, Canada, Bolton et al. (1976) found large differences in yield after continuous cropping. The same was observed by Williams and Schmitthenner (1963) in Ohio, USA. The authors reported that the yield started to decrease from the second year onwards. Having conducted an experiment in the field and in a greenhouse, they also showed that there was a strong negative correlation between root and stem rot and yield. Root and stem rot were most severe with continuous cropping. This fully agrees with what was observed in our experiments. Frequent cultivation of maize caused browning and blackening of the root system (root rot). Application of oxamyl had no visible effect on the infections of the roots. Our suspicion that other soil-borne pathogens were the cause, has been confirmed by a pot experiment (Hellinga et al., 1983), in which the fungicides metalaxyl and captafol applicated to the soil largely prevented root infections. Consequently the differences in yield between continuous cropping and a 1:4 scheme disappeared.

In Ohio, Rao et al. (1978) found that *Pythium* spp. and *Fusarium* spp. were the main causes of root rot. *P. graminicola* in particular was important early in the season. In Ontario, Canada, Whitney and Mortimore (1961) observed that root rot began with an infection of the root tips. As the plants grew older, the infections spread over the entire root system. At a later stage this rot also extended to the stems (stem rot). *F. oxysporum* was thougt to be the main cause of root and stem rot in their experiments. However, the authors state that in other years other fungi may be the cause of rot, depending on the circumstances.

Conclusions

Application of nematicides stimulates the initial growth of maize. However, this improvement has hardly any effect in terms of higher ultimate yields (0-5%).

In contrast to a better distributed rotation, maize in a continuous cropping system shows and early browning and blackening of the root system (root rot), notwithstanding the use of nematicides. These infections are apparently caused by pathogenic soil fungi.

Although no conclusive evidence can be inferred from our experiments, it seems that one must reckon with losses in yield when maize is raised under continuous cropping.

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Samenvatting

De invloed van continuteelt en vrijlevende wortelaaltjes op de opbrengst van snijmaïs

In een serie veld- en potproeven werd nagegaan in hoeverre continuteelt van snijmaïs tot opbrengstdalingen leidt. Hoewel de proeven nog te kort lopen om duidelijke conclusies te trekken, zijn aanwijzingen gevonden dat met opbrengstdervingen rekening gehouden dient te worden. Het wortelstelsel wordt bij continuteelt vroegtijdig en heftig aangetast door pathogene bodemschimmels (wortelrot).

Hoewel toepassing van het nematicide oxamyl tot een uitstekende bestrijding van wortellesieaaltjes leidde en de begingroei van maïs flink werd gestimuleerd, werd de eindopbrengst onder deze gunstige omstandigheden niet of nauwelijks verhoogd.

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