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CONTROL OF FOOT- AND STEMROT OF TOMATOES, CAUSED BY *DIDYMELLA LYCOPERSICI*[1]

Bestrijding van voetrot en „kanker" in tomaten, veroorzaakt door Didymella lycopersici

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Of thirteen compounds the fungicidal action against *D. lycopersici* was tested *in vitro* and *in vivo*. Although none of the fungicides entirely prevented the incidence of disease, four – maneb, nabam, phaltan and captan – greatly decreased the percentages of diseased plants, with maneb being consistently the most effective.

INTRODUCTION

Didymella lycopersici Kleb., which causes foot- and stemrots of glasshouse tomato crops, sometimes seriously decreases yield. From a study of the biology of this fungus, it seemed that the most effective way of minimizing stemrot was to control the footrot phase (VERHOEFF, 1963).

WILLIAMS, SHEARD & READ (1953) studied the chemical control of this fungus on glasshouse crops. An application of a 0.006% solution of ethyl mercuric phosphate round the stem base of tomato plants at a rate of ca 5.5 litre per square meter gave protection against reinfection. Because of the high mammalian toxicity of this fungicide, KNIGHT & KEYWORTH (1960) tested a range of less toxic fungicides with outdoor tomato plants. Of several fungicides, maneb was the most succesful, with eradicant and protective properties when used at concentrations of 1% and 2%. Captan, applied in concentrations of 0.25% and 0.5%, was a good protectant but was less effective as an eradicant.

Because these experiments were done with outdoor tomatoes, I have tested a similar range of materials with glasshouse crops and the results are given in this paper.

MATERIAL AND METHODS

In the present study, four methods of fungicide testing were followed. Unless otherwise stated, the tomato variety 'Ailsa Craig' was used.

In vitro tests

Various concentrations, in water, of the wettable powders of thirteen fungicides were mixed in 10 ml of Conn's agar per petri dish. Each dish was inoculated with a 5 mm disc of *D. lycopersici*, also growing on Conn's agar, and incubated for nine days at 21 °C before the colony diameters of the eight replicates of each treatment were measured.

Tests with young tomato plants

Plants, about 12 cm high, were inoculated by surrounding the stem bases with

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35 g of a 14-days-old sand-oatmeal culture of *D. lycopersici*. Immediately afterwards, 100 ml of fungicide in concentrations of either 0.1% or 0.05% of wettable powder were watered around the stem bases. The liquid formulation of nabam was used at 0.05% and 0.025% of the active ingredient. Experiments were repeated three times, each treatment on each occasion consisting of ten plants. Thirty days after inoculation the diseased plants were counted.

With the most promising compounds, i.e. maneb, nabam, phaltan and captan, the series of experiments was extended to include older plants, about 20 cm high at inoculation.

Comparison of the fungitoxicities of maneb, nabam, phaltan and captan when applied to older plants, grown in whalehide pots.

For inoculation, 75 g of a 14-days-old sand-oatmeal culture of *D. lycopersici* were put into each planting hole, before tomatoes, 20 cm high, were transplanted to 20 cm whalehides. Fungicidal suspensions were watered into the planting hole 24 hours before transplanting or around stem bases 6 or 28 days after transplanting. The suspensions containing 0.1% of the wettable powders of maneb, phaltan and captan were tested; nabam was used at a concentration of 0.05% active ingredient. Single and repeated applications of each fungicide were tested, 200 ml being applied on each occasion.

Measurement of phytotoxicity

Three treatments were tested, singly and in combinations; fungicides were watered (a) into the planting holes 24 hours before transplanting, (b) around stem bases six days after transplanting and (c) around stem bases 27 days after transplanting.

On each occasion 100 ml of fungicidal suspension were applied. Tests were done on a crop of 'Eurocross' planted in July. Cumulative yields were recorded for the three replicate plots, each with 30 plants of the different treatments.

RESULTS

In the *in vitro* tests maneb, nabam, thiram and aretan were the most effective materials, completely inhibiting growth at concentrations as low as 0.003% of wettable powder – for nabam 0.0015% of active ingredient. Allisan, captan and brestan were less inhibitory, but nonetheless appreciably decreased growth.

In experiments with young tomato plants, only maneb and nabam completely prevented attack by *D. lycopersici* at concentrations of 0.05% of wettable powder, respectively 0.025% active ingredient. The other three materials, which were very inhibitory *in vitro*, viz. thiram, aretan and brestan, were significantly less fungicidal *in vivo*. Phaltan and captan, however, give an unexpectedly high degree of control. Because they controlled the attack of *D. lycopersici* with young inoculated tomato plants, further comparisons of maneb, nabam, phaltan and captan were made. None of the compounds entirely prevented the incidence of disease, but all decreased the percentage of plants, dead or with stem lesions from 77% in the untreated controls to ca 15% (Table 1). Most leaflets of plants, treated with captan, developed necrotic margins.

With maneb, nabam, phaltan and captan, seven experiments were done to control footrot of tomato plants after placing the inoculum in the planting hole

TABLE 1. The control of *D. lycopersici* by maneb, phaltan, captan and nabam, when tested on tomato plants, 20 cm high at the inoculation.
Each figure is the average of five experiments; in every test 15 plants were used.
Bestrijding van D. lycopersici *door maneb, phaltan, captan en nabam, getoetst met tomateplanten, 20 cm hoog op het moment van de inoculatie. Elk cijfer is het gemiddelde van vijf proefseries; per serie werden 15 planten gebruikt.*

Fungicide	% Plants killed *% Dode planten*	% Plants with stem lesions *% Planten met stengellesies*	Total % *Totaal %*
Maneb	2	10	12
Phaltan	4	12	16
Captan	3	12	15
Nabam	6	9	15
Untreated control . . *Onbehandeld*	28	49	77

before transplanting, instead of at the stem bases as in the earlier experiments.

The results are summarized in Table 2. The data for the fungicidal treatments are expressed as percentages of those recorded for the untreated controls, the average percentage of dead plants and with basal stem lesions for the untreated control being 57.9 %. Again, none of the fungicides gave complete control, but maneb was usually the most effective fungicide.

Applying maneb, nabam and captan in the absence of *D. lycopersici* did not affect yield significantly, although the leaflets on captan treated plants developed necrotic margins, about eight days after the post-planting fungicide application.

DISCUSSION

Out of thirteen fungicides, maneb gave the most satisfactory control of footrot of tomato plants, caused by *D. lycopersici*. This agrees with the results of KNIGHT & KEYWORTH (1960). In Britain, however, maneb is not used in glasshouse crops in case it aggravates manganese toxicity following partial sterilization of soil by steam. Instead captan, which is less fungitoxic, is recommended at concentrations reaching 1 % of the wettable powder in water (ANONYMOUS, 1964). In my experiments, however, captan used at concentrations as low as 0.1 % of the wettable powder was phytotoxic, leaflets developing necrotic margins within eight days of the post-planting application. At a concentration of 1 % of the wettable powder, maneb is phytotoxic too, but when applied at 0.1 % either to the planting hole or around stem bases, no damage occurs.

Although maneb does not give complete control of footrot caused by *D. lycopersici*, results from its use on commercial crops during two seasons are very satisfactory. In heavily infested soil, the degree of footrot control reaches 90 %; in less seriously infested soils, control is virtually complete. If the few plants with *Didymella*-footrot are removed, stem infections will not occur.

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TABLE 2. Fungicidal action of maneb, phaltan, captan and nabam against *D. lycopersici* when applied to tomatoes grown in whalehide pots (inoculum was put into the planting holes). On each occasion 200 ml of fungicidal suspension were applied. The data are expressed as percentages of those recorded for the untreated control.
Fungicide werking van maneb, phaltan, captan en nabam tegen D. lycopersici, *getoetst met tomateplanten, groeiend in nul-potten (het inoculum was in de plantgaten gebracht). Bij elke behandeling werd 200 ml van de fungicide-suspensie toegediend. De uitkomsten zijn weergegeven in procenten van de besmette controle.*

Fungicide	Dates of fungicide application in relation to the date of inoculation; fungicides were applied either into the planting hole or around bases of stems *Tijdstip van toediening van de fungiciden in afhankelijkheid van het tijdstip van inoculeren; de fungiciden werden in het plantgat of rond de stengelbases gegoten*											
	24 hours before planting *24 uur voor het planten*			Five days after planting *Vijf dagen na het planten*			24 hours before and five days after planting *24 uur voor en vijf dagen na het planten*			24 hours before, five days after and four weeks after planting *24 uur voor, vijf dagen na en vier weken na het planten*		
	A[1]	B[1]	C[1]	A	B	C	A	B	C	A	B	C
Maneb, 0.1% of the wettable powder in water *0.1% van het spuitpoeder in water*	5.5	22.0	27.5	20.0	26.0	46.0	0.9	9.2	10.1	1.9	4.2	6.1
Phaltan, idem	12.5	11.4	23.9	46.0	15.0	61.0	11.2	11.2	22.4	2.6	7.6	10.2
Captan, idem	6.1	14.3	20.4	43.6	27.8	71.4	10.6	6.5	17.1	7.3	8.6	15.9
Nabam, 0.05% of the active ingredient in water *0.05% van het werkzaam bestanddeel in water*	14.1	16.0	30.1	52.6	24.3	76.9	9.0	7.9	16.9	9.0	3.9	12.9

[1] A: % Plants killed within ten weeks/% *Planten, binnen tien weken afgestorven.*
B: % Plants with basal stem lesions/% *Planten met stengellesies onder het grondoppervlak.*
C: Total % of diseased plants/*Totaal % aangetaste planten.*

SAMENVATTING

Uit eerder onderzoek is gebleken, dat de primaire infectiebron voor het ontstaan van stengelaantastingen door *Didymella lycopersici* Kleb., de zogenaamde „kanker" in tomaten, gelegen is in het door deze schimmel veroorzaakte voetrot. Effectieve bestrijding van deze stengelaantastingen bestaat derhalve in het tegengaan van het voetrot.

Dertien fungiciden zijn *in vitro* getoetst, door na negen dagen de groei van de schimmel op Conn's agar, waaraan deze middelen in verschillende concentraties als spuitmiddel waren toegevoegd, te meten. Slechts aretan, thiram, maneb en nabam onderdrukten de myceliumgroei geheel. De fungiciden zijn daarna op jonge, geïnoculeerde tomateplanten getoetst, waarna de meest belovende middelen – maneb, phaltan, captan en nabam – getoetst zijn op oudere planten (tabel 1). In beide proefseries werd het inoculum, bestaande uit een veertien dagen oude cultuur van *D. lycopersici*, groeiend op zand vermengd met havermoutextract, rondom de stengelbasis gebracht. De vier genoemde middelen werden vervolgens getoetst met planten, groeiend in nulpotten, waarbij het inoculum in de plantgaten was gebracht. Op verschillende tijdstippen na de inoculatie werden de fungiciden toegediend (tabel 2).

Hoewel geen van de middelen algehele bestrijding van *D. lycopersici* geeft, wordt de aantasting wel sterk tegengegaan, met name door toediening van maneb. Na gebruik van maneb, nabam en captan op de in tabel 2 aangegeven wijze, waarbij 100 ml per behandeling werd gebruikt, trad geen significant verschil in opbrengst op.

REFERENCES

ANONYMOUS, – 1964. Notes on Didymella control. L.V.G.A. News letter 208: 33.

KNIGHT, D. E. & W. G. KEYWORTH, – 1960. Didymella stemrot of outdoor tomatoes II. Studies on chemical control. Ann. appl. Biol. 48:259–262.

VERHOEFF, K., – 1963. Voetrot en „kanker" bij tomaat, veroorzaakt door Didymella lycopersici. Neth. J. Plant Path. 69: 298–313.

WILLIAMS, P. H., E. SHEARD & W. H. READ, – 1953. Didymella stem-rot of the tomato. J. hort. Sci. 28: 278–294.