The effect of disinfectants on fungal diseases of cucumber

HANNA AVIKAINEN, HILKKA KOPONEN and RISTO TAHVONEN

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Formaline, Iobac P, sodium hypochlorite (NaOCl), Korsolin and Menno-Ter-forte were effective disinfectants in the control of damping-off (*Pythium* sp.) from peat substrate. Ipasept, Sanisept and Virkon S (1%) were shown ineffective against *Pythium* sp. in peat. Only formaline was effective in the control of black root rot (*Phomopsis sclerotioides*) from peat. In sand substrate *P. sclerotioides* could be eradicated also with sodium hypochlorite. Verticillium wilt (*Verticillium dahliae*) from peat substrate could be controlled with formaline, Iobac P, sodium hypochlorite and Virkon S. Formaline and sodium hypochlorite were effective against Verticillium wilt in sand. Black stem rot (*Didymella bryoniae*) was susceptible to all disinfectants tested.

Key words: *Didymella bryoniae*, disinfection, *Phomopsis sclerotioides*, *Pythium* sp., *Verticillium dahliae*

Introduction

The production of cucumber starts in Finland by growing seedlings in artificial light at the end of December. The greenhouses must be clean and free of diseases and pests in order to get high quality seedlings. Either new peat or rock wool is used as seedling growth substrate. One of the major risks is the damping-off. The cultivation is continued at the end of January in normal greenhouse conditions using as growth substrate rock wool or new peat isolated from ground soil with a plastic sheet or plastic bags. The major diseases are various root diseases and stem and leaf diseases during the growing season. Therefore the growing places must be free from diseases and pests before planting the seedlings. It is very common that farmers change plants during the summer to get a higher yield and a better quality in autumn. The risk of severe disease infection is great, because diseases may spread with plant debris from old to new plants.

Pythium sp., which causes damping-off, is a major problem in cucumber cultivation in Finland. Also black stem rot (*Didymella bryoniae*) is common and difficult to control. Black root rot (*Phomopsis sclerotioides*) and *Verticillium* wilt (*Verticillium dahliae*) are severe diseases of cucumber (FLETCHER 1984). Black root rot is a very common disease on cucumber in Finland (MURMAN 1992). *Verticillium* wilt causes losses in open fields in southwestern Finland and in some cases in greenhouses in western Finland (TAHVONEN 1987). There are no resistant cultivars or effective fungicides to control these diseases.

Disinfection of the soil has previously been investigated as a means to control fungi (LINNASALMI 1955). Today, the growth substrate is changed every year (MURMAN 1992), which makes

Table 1. The disinfectants, their active substances and the concentrations recommended by the manufacturers.

Disinfectant	Active ingredient, %	Recommended concentration, %
Desinfektol EL	Ethanol, 60	undiluted
Formaline	Formaldehyde, 37	5.0
Iobac P	Iodine, 1.8	3.0
Ipasept	Quaternary ammonium compounds, 2.8	2.0
Korsolin	Glutaraldehyde, 10	1.0
Menno-Ter-forte	Quaternary ammonium compounds, 32.5	1.0
Sanisept	Quaternary ammonium compounds, 2.5	2.0
Sodium hypochlorite (NaOCl)	Active chlorine, 10	10.0
Taloset	Quaternary ammonium compounds, 3.5	2.0
Virkon S	Potassium peroxysulphate, 60	1.0

disinfection of soil unnecessary. The pathogens do, however, survive in plant debris and in soil particles as well as in the greenhouse structures for a long time. Disinfection of the structures and equipment is therefore still necessary.

This disinfection study was carried out in 1988-1990 to establish the applicability of different disinfectants in plant production and their effect on fungal pathogens of cucumber. The research is part of a study carried out jointly by the University of Helsinki, the Technical Research Centre of Finland and the Agricultural Research Centre.

Material and methods

Disinfectants and fungi

Ten commercial disinfectants were tested on fungal pathogens of cucumber (Table 1). The concentrations recommended by the manufacturers were used in the trials. Any deviations from these concentrations are given in the tables. The disinfectants were diluted in tap water.

The tested fungi were *Didymella bryoniae, Phomopsis sclerotioides, Pythium* sp. and *Verticillium dahliae*. The names of the fungi are according to

Table 2. The growth media used in the fungal cultures.

Fungus	Growth medium
Didymella bryoniae	Corn meal agar (Difco) + 100 ppm streptomycin sulphate
Phomopsis sclerotioides	Malt extract agar (Difco)
	Corn meal agar (Difco) + 100 ppm streptomycin sulphate
Pythium sp.	Martin's medium
Verticillium dahliae	Corn meal agar (Difco) + 100 ppm streptomycin sulphate

DOMSCH et al. (1980). The fungal isolates included in the study were obtained the collections of the Institute of Plant Protection of the Agricultural Research Centre. The fungi were cultivated on different media depending on the fungus (Table 2). The formulas for culture media of fungi are presented in BOOTH (1971).

The effect of disinfectants on *Pythium, Didymella* and *Verticillium* in peat and plant debris in laboratory experiments

The effect of concentration and disinfection time in the control of cucumber pathogens in peat and plant debris was investigated in laboratory trials. In testing *Pythium* sp. and *V. dahliae* the method used for testing the effect of disinfectants on *Fusarium culmorum* and *F. oxysporum* in peat was used (KOPONEN et al. 1993). However, the amount of peat mixed in disinfectant was 1 g and 5 g in the *V. dahliae* trial and the exposure time was 15 and 60 min. In the *D. bryoniae* trial, the inoculate used was obtained by mixing five infected pieces (about 5 cm long) of cucumber stem and 200 ml of disinfection dilution (N and 10^{-1} N) with a homogenizer. The disinfectants were allowed to act for 10 and 100 min. Filtering and fungal cultivation were carried out as above in the *Pythium* and *V. dahliae* experiments.

The effect of the disinfectants on *D. bryoniae, Pythium* sp. and *V. dahliae* on plastic surfaces contaminated with fungus-peat or plant debris mixture was investigated in a laboratory trial. The trial was carried out as described in KOPONEN et al. (1993),

testing the effect of disinfectants on *Fusarium culmorum* and *Botrytis cinerea* on polyethene surface.

All the above trials were made with three replicates. The plates were evaluated after one and three weeks. The results were calculated as efficiency percentages, i.e. the proportion of healthy pieces on agar plates of all pieces.

The effect of disinfectants on pathogens in greenhouse experiments

Peat experiment on Pythium

In the *Pythium* trial, the plastic pots were contaminated by growing in them infected cucumber seedlings for 5 weeks. The cucumber seedlings were inoculated with naturally infected *Pythium* peat (20 g oat flour/1 l peat). When the seedlings were infected and started to wilt, the growth substrates were allowed to dry. The pots were emptied and the dry peat debris (1-2 g) was washed with disinfection solution using a brush and a propane sprayer (pressure of 4 bar). After 30 min the wash suspension (300-400 ml) was filtered. The filter paper with peat was mixed in 200 ml of water with a homogenizer and the mixture was used for biotests.

In the biotest, cucumber seedlings cv. 'Daleva' (7 days old) were used as test plants. The mixture (10 ml) was applied onto the oat-peat collar around the base of the seedlings. The first 24 hours the cucumbers were kept in the dark at +12-15°C, thereafter at 20°C in greenhouse with a light period of 12 hours (BOUHOT 1975 a, b). There were four replicates, with five seedlings per treatment. Observations on the infected and dead plants were made daily four days after the treatments. The cucumbers were grown for 15 days. At the end of the trial the damage caused to the seedling and the roots was evaluated on a rating scale of 0-3: 0=healthy plant, 1=slightly infected base, 2=off-white and browned roots, and severely browned base, 3=wilted seedling and dead roots. The efficiency percentage of the disinfectants was calculated by comparing the severity of damage to the healthy and affected control using the formula:

$$\text{efficiency } \% = \frac{c-b}{a-b} \cdot 100$$

a=severity of infection in healthy control
b=severity of infection in water control
c=severity of infection in disinfection treatment.

Peat experiment on Phomopsis and Verticillium

The effect of disinfectants on *P. sclerotioides* and *V. dahliae* in peat was investigated by mixing 100 ml of fungus-peat (one Petri dish culture of fungi/100 ml water/1 l peat) inoculate in 2 l of diluted disinfectant. The disinfection solution with peat was filtered after 60 min and the peat was rinsed twice with water. Treated peat (3 g) was placed on the bottom of the pots. The pots (1 l) were filled with clean peat. As test plants were used two-day-old pregerminated cucumber seeds which were grown for 4-6 weeks, or one-week-old seedlings grown until fruit production (about 10 weeks). The number of replications was three with three plants per treatment.

At the end of the trial the severity of damage in the shoots and roots was evaluated on a rating scale of 0-3: 0=healthy, 1=slightly infected base and roots, 2=partly wilted leaves and roots, 3=dead plant. The efficiency percentage was calculated from the mean of the trials, comparing the effect of the disinfectants on the healthy and infected control like in the *Pythium* trial.

The viability of *V. dahliae* on the cucumber stem was determined in laboratory. Pieces (5 cm) were taken from the base of the shoot. From these pieces were cut small pieces (0.5 cm) and placed on corn meal-streptomycin medium, four pieces per plate, and three plates per plant. The fungi grown on the pieces were evaluated after one and three weeks. The efficiency percentage was calculated as the proportion of healthy pieces of all pieces.

Sand experiment on Phomopsis and Verticillium

The effect of the disinfectants on *P. sclerotioides* and *V. dahliae* in sand was also investigated. The sand was inoculated by mixing fungal suspension (one fungus culture/100 ml water) in 1 l of sand.

Table 3. The effect of concentration and disinfection time on *Pythium* sp. in peat debris. Disinfectants and concentrations (N): 1 = formaline (5%), 2= Iobac P (3 %), 3= Ipasept (2 %), 4= Korsolin (1 %), 5= Menno-Ter-forte (1 %), 6 = NaOCl (10 %) and 7 = Virkon S (2 %).

Concentration of disinfectant	Peat g/1 l disinfectant	Time, min	Disinfectant 1	2	3	4	5	6	7
			Efficiency %						
Concentration (N)	1	1	42	100	100	100	100	100	92
		10	92	100	100	100	100	100	100
		100	100	100	100	100	100	100	100
	0.1	1	58	100	100	100	100	100	100
		10	100	100	100	100	100	100	100
		100	100	100	100	100	100	100	100
10^{-1} N	1	1	-	92	100	0	100	16	67
		10	-	100	100	0	100	63	92
		100	-	100	100	92	100	91	100
	0.1	1	-	100	100	100	100	83	100
		10	-	100	67	100	100	100	100
		100	-	100	92	100	100	100	100

Table 4. The effect of concentration and disinfection time on *Verticillium dahliae* in peat debris. Disinfectants and concentrations (N): 1= formaline (5 %), 2= Iobac P (3 %), 3= Ipasept (2 %), 4= Menno-Ter-forte (1 %), 5=NaOCl (10 %), 6 = Taloset (3 %), 7 = Virkon S (2 %).

Concentration of disinfectant	Peat g/1 l disinfectant	min	Time, Disinfectant 1	2	3	4	5	6	7
			Efficiency %						
Concentration (N)	5	15	100	0	0	42	17	17	67
		60	100	50	0	92	58	17	92
	1	15	75	33	8	25	50	0	92
		60	92	8	0	92	92	0	100
10^{-1} N	5	15	100	0	0	0	0	0	92
		60	100	0	0	0	0	0	67
	1	15	67	0	0	0	0	0	67
		60	100	0	0	17	8	0	42

One litre of inoculated sand was put into plastic pots and 60 ml (approx. 4 l/m^2) of disinfection dilution was sprayed onto the sand surface. After one hour of treatment the sand was washed with water and filtered. The holes in the peat substrate were filled with 30 g of treated sand and the one-week-old cucumber seedlings were planted there. The number of replications was three or five with three seedlings per treatment.

At the end of the trial (3-5 weeks) the severity of damage to shoots and roots was evaluated as above in the peat experiment on *Phomopsis*. The trial was repeated three times on *P. sclerotioides* and twice on *V. dahliae*. The results were calculated in the same way as in the peat trials on *Pythium*.

Analysis of variance was used in the statistical analysis of the results. Significances were tested with Tukey's test.

Table 5. The effect of disinfectants on *Didymella bryoniae* in cucumber debris.

Treatment	Concentration %	Disinfection time, min 10	100
		Efficiency %	
Water		0	0
Iobac P	1	83	92
	0.1	0	0
Ipasept	2	100	100
	0.2	0	0
Korsolin	2	100	100
	0.2	8	0
Menno-Ter-forte	1	100	100
	0.1	92	42
NaOCl	10	100	100
	1	75	100

Results

In the laboratory experiment, all tested disinfectants were effective against *Pythium* sp. in peat debris when recommended concentrations were used. Even one minute treatment time was sufficient for all disinfectants except formaline and Virkon S. Menno-Ter-forte, Ipasept and Iobac P were effective against *Pythium* sp. (Table 3) at a lower than the recommended concentration.

Laboratory trials showed that *Verticillium dahliae* in peat debris was difficult to eradicate; only formaline was effective against this species. Virkon S and Menno-Ter-forte were also rather effective when the influence time was 60 min. Iobac P and Ipasept were the weakest disinfectants (Table 4).

All the tested disinfectants were rather effective against *Didymella bryoniae* in plant debris at recommended concentrations when 10 min treatment time was used. Only 1% Iobac P did not eradicate completely *D. bryoniae* (Table 5).

Soaking the plastic pots contaminated with peat and fungus for 15-60 min in the disinfectant was sufficient to eradicate *D. bryoniae* and *Pythium* sp. but not *V. dahliae*. However, Ipasept and Sanisept were ineffective against *Pythium* sp. and Ipasept against *D. bryoniae* (Table 6). *V. dahliae* was more difficult to eradicate than *Pythium* sp. and *D. bryoniae*. However, Iobac P and NaOCl eradicated *V. dahliae* perfectly after 15 min treatment time. Also the effect of formaline, Korsolin and Menno-Ter-forte on this fungus was over 90 % after 60 min treatment time (Table 6).

In the greenhouse experiment, disinfestation of *Pythium* sp. from the surface of plastic pots was the most successful with formaline, Iobac P, Korsolin, NaOCl and Menno-Ter-forte. Ipasept,

Table 6. The effect of disinfectants on fungi on the surface of plastic pots contaminated with peat-fungus mixture.

Treatment	Concentrations %	*Didymella bryoniae*	*Pythium* sp.	*Verticillium dahliae*
		Minimum time min/efficiency %		
Water		60/0	60/50	60/17
Formaline	5	15/100	15/100	60/92
Iobac P	3	15/100	15/100	15/100
Ipasept	2	60/58	60/17	60/83
Korsolin	1	15/100	60/100	60/100
Menno-Ter-forte	1	15/100	60/92	60/92
NaOCl	10	15/100	60/100	15/100
Sanisept	2	15/100	60/42	60/58
Taloset	3	60/92	-	60/75
Virkon S	2	15/100	15/100	60/75

Table 7. The effect of disinfectants on *Pythium* sp. in peat debris. Cucumber seedlings were used as test plants. Disease index: 0= healthy, 3= dead.

Treatment	Disease index, 0-3		Efficiency %	
	Trial 1	Trial 2	Trial 1	Trial 2
Healthy control	0 a	0 a		
Water	2.60 b	2.34 b		
Formaline	-	0.25 a	-	89
Iobac P	0.15 a	0.10 a	94	96
Ipasept	1.95 b	-	25	-
Korsolin	0.20 a	-	92	-
Menno-Ter-forte	0.05 a	0.45 a	98	81
NaOCl	0.05 a	0.60 a	98	74
Sanisept	2.20 b	-	15	-
Virkon S 1 %	-	1.88 b	-	20
F-values	58.98***	19.29***		

Values in columns marked with the same letter do not differ at P=0.05.
***= P 0.001

Table 8. The effect of disinfection on *Phomopsis sclerotioides* in peat debris. Trials 1-2 lasted about 5 weeks, trials 3 and 4 until at fruit production. Disease index: 0= healthy roots, 3= dead roots. The effect of disinfectants was tested on cucumber.

Treatment	Disease index, 0-3				Efficiency %
	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Healthy control	0.56 a	0.28 a	0 a	0 a	
Water	1.50 b	0.92 b	2.56 c	3.00 c	
Formaline	0.24 a	0.56 a	0.11 a	0.22 a	96
Iobac P	1.43 b	0.56 a	2.34 c	1.22 b	34
Ipasept	-	-	-	1.56 b	-
Menno-Ter-forte	0.45 a	0.61 a	0.67 a	0.33 a	83
NaOCl	1.77 b	0.45 a	2.22 c	0.94 a	36
Taloset	1.24 b	0.28 a	-	0.89 a	67
Virkon S (2 %)	0.22 a	0.56 a	1.33 b	0.44 a	76
F-values	4.72**	7.68***	31.5***	24.75***	

Values in columns marked with the same letter do not differ at P=0.05.
** = P 0.01, ***= P 0.001

Sanisept and Virkon S (1 %) were weakly effective against *Pythium* sp. (Table 7).

Phomopsis sclerotioides in the peat debris on the surface of plastic pots was eradicated by formaline in the greenhouse trial. Menno-Ter-forte and Virkon S were moderately effective against the fungus. The effect of Iobac P and NaOCl varied greatly in the different trials. They performed poorly in trials where the seedlings had been grown until fruit production (Table 8). The most effective disinfectants against *V. dahliae* in peat were formaline, Iobac P, NaOCl and Virkon S. Taloset was the least effective (Table 9).

P. sclerotioides was effectively eradicated from sand substrate by formaline and NaOCl. Also Menno-Ter-forte was moderately effective. The least effective disinfectants against *P. sclerotioides* in sand were Virkon S and Taloset (Table 10).

Table 9. The effect of disinfection on *Verticillium dahliae* in peat debris. Trials 1 and 2 lasted 6 weeks, trials 3 and 4 until fruit production. Results are based on laboratory cultures from the base pieces of cucumber seedlings. The effect of disinfectants was tested on cucumber.

Treatment	Healthy plants %				Efficiency %
	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Healthy control	100.0 a	91.7 a	100.0 a	95.4 a	
Water	61.1 ab	35.2 b	66.7 b	10.4 b	
Desinfektol EL	-	-	-	77.8 a	-
Formaline	88.9 ab	92.6 a	83.3 ab	83.6 a	82
Iobac P	100.0 a	85.2 a	91.7 ab	73.2 a	83
Ipasept	55.6 b	-	88.9 ab	-	-
Menno-Ter-forte	77.8 ab	86.1 a	94.5 a	58.4 ab	67
NaOCl	88.9 ab	95.4 a	86.1 ab	75.5 a	81
Taloset	66.7 ab	88.0 a	77.8 ab	0 b	28
Virkon S (2 %)	100.0 a	77.8 a	91.7 ab	82.9 a	84
F-values	3.17*	8.69***	3.08*	9.75***	

Values in columns marked with the same letter do not differ at P=0.05.
* = P 0.05, ***= P 0.001

Table 10. The effect of disinfection on *Phomopsis sclerotioides* in sand substrate. Disease index: 0= healthy roots, 3= dead roots. The effect of disinfectants was tested on cucumber.

Treatment	Disease index, 0-3				Efficiency %
	Trial 1	Trial 2	Trial 3	Mean	Mean
Healthy control	0 a	0 a	0 a	0	
Water	2.40 c	2.00 c	2.00 b	2.13	
Desinfektol EL	-	1.00 b	0.53 ab	0.77	-
Formaline	0.20 a	0.67 ab	0.13 a	0.33	85
Iobac P	0.40 a	0.89 b	0.80 b	0.70	67
Menno-Ter- forte	0.40 a	0.78 ab	0.40 a	0.53	75
NaOCl	0.40 a	0.22 ab	0.07 a	0.23	89
Taloset	0.20 a	1.22 bc	1.27 b	0.90	58
Virkon S (2 %)	0.80 b	1.33 bc	1.34 b	1.16	46
F-values	18.64***	11.09***	14.04***		

Values in columns marked with the same letter do not differ at P=0.05.
***= P0.001

The most effective preparations for disinfection of sand substrate from *V. dahliae* were formaline and NaOCl. Iobac P was moderately effective. The least effective disinfectants were Taloset, Virkon S and Menno-Ter-forte. Desinfektol EL was equal to formaline in the first trial but ineffective in the second (Fig. 1).

Discussion

The laboratory trials showed that all disinfectants were effective against *Pythium* sp. in peat at 10 min treatment time. In the greenhouse trials trying to disinfect plastic pots and washing suspension from *Pythium* sp., only Ipasept, Sanisept and Virkon S

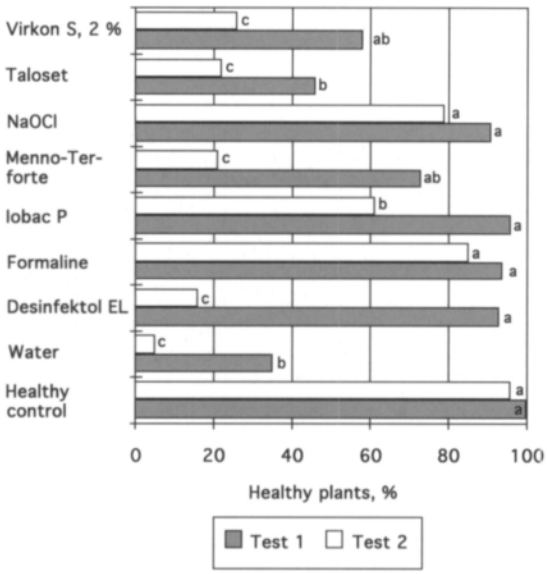

Fig. 1. The effect of disinfection on *Verticillium dahliae* in sand substrate. Bars marked with the same letter do not differ significantly at P=0.05.

(1%) were ineffective. The results are in accordance with the laboratory results of BAANDRUP (1983) and KOPONEN et al. (1992).

In the laboratory trials, *Didymella bryoniae* was easily eradicated at 10 min treatment time from peat debris. Only Iobac P was not effective against *D. bryoniae* because it was used at a concentration of 1 %. Formaline, Menno-Ter-forte, Iobac P and Virkon S eradicated the fungus completely also from the surface of the plastic pots. According to KOPONEN et al. (1992), too, Menno-Ter-forte and NaOCl have yielded good result on plastic surfaces against *D. bryoniae*. This fungus has been effectively disinfested from wood surface and paper by formaline and Virkon S, respectively, (SUNDHEIM 1991). In agar tests carried out by JOHANSSON (1985), Korsolin (1%) and Menno-Ter-forte (0.5%) did not prevent the growth of *D. bryoniae* at 1 min treatment time. Also in this study Korsolin was ineffective against *D. bryoniae* on plastic surface.

In greenhouse trials only formaline was effective against *Phomopsis sclerotioides* mixed in peat. Menno-Ter-forte and Virkon S were moderately effective. NaOCl, in addition to formaline, was effective against the fungus mixed in sand. However, SUNDHEIM (1989) has reported that formaline (as fumes or sprays) was not effective against *P. sclerotioides* in greenhouse experiment. In agar tests carried out in Sweden, Korsolin (1%) and Menno-Ter-forte (0.5%) did not inhibit the growth of *P. sclerotioides* after one minute influence time (JOHANSSON 1985). According to SUNDHEIM (1989), only formaline was effective against *P. sclerotioides* on wood pieces in laboratory test. According to SUNDHEIM (1991), Menno-Ter-forte was effective against *P. sclerotioides* in the paper test and Virkon S (1%) was ineffective. According to KOPONEN et al. (1992), many disinfectants (e.g. Menno-Ter-forte, NaOCl, Virkon S) need at least 60 min exposure time against *P. sclerotioides* to reach over 95 % effect in laboratory circumstances.

The laboratory tests showed that only formaline was effective against *V. dahliae* in peat debris. Iobac P, Korsolin and NaOCl eradicated the fungus completely from the surface of plastic pots. According to BRIELMAIER (1985), Menno-Ter-forte has been effective against *V. dahliae* after 10 min influence time in a laboratory experiment, but in this study Menno-Ter-forte gave 92 % effect after 60 min on plastic surface. According to KOPONEN et al. (1992), Desinfectol EL, Menno-Ter-forte and NaOCl were effective against *V. dahliae* on synthetic cloth and plastic surface after 60 min influence time in a laboratory test.

In greenhouse trials formaline, Iobac P, NaOCl and Virkon S were effective against *V. dahliae* in peat debris. Formaline and NaOCl were the most effective against the fungus in sand. The effect of Iobac P and Desinfectol EL varied in different trials. Menno-Ter-forte and Virkon S were ineffective against *V. dahliae*. In the greenhouse trials the effect of disinfectants varied in different trials. None of the disinfectants eradicated *V. dahliae* totally from peat debris. The most effective disinfectants against *V. dahliae* in peat debris were formaline, Iobac P, NaOCl and Virkon S. *V. dahliae* in sand substrate were eradicated most effectively by formaline and NaOCl. The effect of Iobac P and Desinfectol EL varied in different trials.

The results show that all the tested disinfectants

are effective against *Pythium* sp. and *Didymella bryoniae*. The effect of Ipasept, Sanisept and Korsolin varied. Virkon S should be used at concentrations of at least 2 %. Formaline is the most effective against *Phomopsis sclerotioides* and *Verticillium dahliae*.

Although a treatment time of 10 or 15 min was sufficient for most disinfectants to kill the fungi in the laboratory, a disinfection time of at least 60 min is recommended in practice.

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Hanna Avikainen
Risto Tahvonen
Agricultural Research Centre of Finland
Institute of Plant Protection
FIN-31600 Jokioinen, Finland

Hilkka Koponen
Department of Plant Biology
P.O.Box 28
FIN-00014 University of Helsinki, Finland

SELOSTUS

Desinfiointiaineiden teho kurkun sienitauteihin

HANNA AVIKAINEN, HILKKA KOPONEN ja RISTO TAHVONEN

Maatalouden tutkimuskeskus ja Helsingin yliopisto

Kymmenen desinfiointiaineen tehoa kurkun *Didymella bryoniae-*, *Pythium* sp.-, *Phomopsis sclerotioides-* ja *Verticillium dahliae-* tauteja vastaan testattiin laboratorio ja kasvihuoneolosuhteissa vuosina 1988-1990. Tutkittavat valmisteet olivat Desinfektol EL (etanoli), formaliini (formaldehydi), Iobac P (jodi), Ipasept, Menno-Ter-forte ja Sanisept ja Taloset (kvartaarisia ammoniumyhdisteitä), Korsolin (glutaraldehydi), natriumhypokloridi (aktiivinen kloori) ja Virkon S (kaliumperoksisulfaatti).

Laboratoriotesteissä testattiin valmisteiden suositeltujen käyttöväkevyyksien ja niistä tehtyjen laimennosten tehoa turpeessa tai kasvijätteissä oleviin taudinaiheuttajiin. Lisäksi tutkittiin käsittelyajan vaikutusta valmisteiden tehoon. Kasvihuonetesteissä kasvatettiin kurkun taimia sienillä infektoidulla turpeella liatuissa, desinfioiduissa muoviruukuissa. Valmisteiden tehoa testattiin myös *Phomopsis-* ja *Verticillium* -sienillä infektoidun hiekka-alustan desinfioinnissa.

Pythium-sienen aiheuttamaan kurkuntaimipolte- ja tyvitautiin tehosivat hyvin formaliini, Iobac P, NaOCl, Korsolin ja Menno-Ter-forte. Heikkoja valmisteita olivat Ipasept, Sanisept ja Virkon S (1%). Formaliini oli tehokkain kurkunmustajuurimädän (*Phomopsis sclerotioides*) desinfioinnissa. Hiekka-alustalla oleva sieni voitiin hävittää myös NaOCl:lla. *Verticillium*-sienen aiheuttama kurkunlakastumistauti torjuttiin parhaiten formaliinilla, Iobac P:llä, NaOCl:lla ja Virkon S:llä. Hiekan joukossa olevaan taudinaiheuttajaan tehosivat formaliini ja NaOCl. *Didymella bryoniae* oli herkkä useimmille tutkituille desinfiointiaineille.

Desinfiointiajaksi suositellaan vähintään tunnin käsittelyaikaa, vaikka lyhyempikin aika laboratoriotesteissä saattoi antaa hyvän tuloksen.