The effect of disinfectants on fungi in pure culture and on different surface materials

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The effect of eight disinfectants was tested on 11 fungi. The concentrations recommended by the manufacturers were mostly used in the present trials. Five and 15 min treatment times were too short for most preparations. The best efficacy was achieved at 60 min treatment time. In pure cultures, all disinfectants tested were most effective against *Pythium* sp. Overall, the most effective preparation was Desinfektol EL which was effective against all fungi tested at 5 min treatment time.

Wood surfaces were more difficult to disinfest than metal and plastic surfaces. *Rhizoctonia solani* and *Verticillium dahliae* were highly susceptible only to Desinfektol EL, and NaOCl controlled *Pythium* sp. and *Botrytis cinerea*. None of the preparations controlled completely the other test fungi.

On metal surfaces the most effective disinfectants were Desinfektol EL and NaOCl; moderately effective were Iobac P and Menno-Ter-forte. Korsolin was the least effective preparation. *Verticillium dahliae* and *Phomopsis sclerotioides* were difficult to kill. The easiest fungi to disinfest were *Pythium sp., Rhizoctonia solani, B. cinerea, Fusarium avenaceum, F. culmorum, F. oxysporum*, *Mycocentrospora acerina* and *Phoma foveata*.

Fungi grown on plastic surfaces were best controlled with Desinfektol EL. Also NaOCl, Menno-Ter-forte and Iobac P were effective. Korsolin was the least effective preparation. The easiest fungi to eradicate were *Pythium* sp. and *R. solani*. The most difficult fungi were *V. dahliae* and *P. sclerotioides*. Both peat and clay deteriorated the efficacy of the disinfectants except for Desinfektol EL.

Key words: disinfection, metal surface, plant pathogens, plastic surface, wood surface

Introduction

Farmers and agricultural advisors have been inquiring about the applicability of disinfectants for disinfection of greenhouses and storages. There are several commercial disinfectants on the market. Many of the preparations available are intended for use in hospitals, food industry and domestic animal farms, less frequently for disinfection of greenhouses and storages.

There is little experimental data in the literature on the effect of disinfectants on plant pathogenic fungi and their use for control of plant pathogens (BRIELMAIER 1985, BÅNG 1987, BÖHMER 1983,

LØSCHENKOHL et al. 1990, SUNDHEIM 1989).

In greenhouses it is not necessary to disinfect the soil, because the growth substrate is changed after each growing period and plastic containers are used. However, it is still important to disinfect the benches and equipment, because many plant pathogens may survive for long periods of time in structures and plant debris, even in soil, until the next growing season. Important plant diseases of cucumber and tomato seedlings in greenhouse include *Pythium* spp. and *Rhizoctonia solani*; diseases occuring later in the roots and stems of older plants include *Phomopsis sclerotioides, Didymella bryoniae, Verticillium dahliae*, *Fusarium* spp., *Botrytis cinerea* and *Sclerotinia sclerotiorum* (FLETCHER 1984). These pathogens may also be carried over from one place to another by means of the equipment and pots.

Pathogens in winter storages of potatos and vegetables are carried in with the products. Annual disinfection before the storage period reduces the number of pathogens persisting in the storage structures. Significant pathogenic fungi in storages of potatoes and vegetables include e.g. *Fusarium* spp., *Botrytis cinerea, Mycocentrospora acerina, Phoma foveata, Sclerotinia sclerotiorum, Sclerotium cepivorum* and *Typhula* sp. (SEPPÄNEN 1983, TAHVONEN 1981 a, b).

Table 1. The disinfectants tested for control of fungi.

Disinfectant	Active ingredient %	Tested concentration %
Desinfektol EL	Ethanol, 60.0	undiluted
Iobac P	Iodine, 1.8	3.0
Ipasept	Quaternary ammonium compounds, 2.8	2.0
Korsolin	Glutaraldehyde, 10.0	1.0
Menno-Ter-forte	Quaternary ammonium compounds, 32.5	1.0
Sodium hypochlorite (NaOCl)	Active chlorine, 10.0	10.0
Taloset	Quaternary ammonium compounds, 3.5	2.0
Virkon S	Potassium peroxysulphate, 60.0	1.0

The present study was undertaken in vitro to determine the effect of some commonly used disinfectants on plant pathogenic fungi in pure culture and on wood, plastic and metal surfaces, as well as the effect of peat and clay on the efficacy of disinfection. Some of the commonly used disinfectants, e.g. formaldehyde, are hazardous to the user's health. Therefore we tried to find alternatives.The effect of disinfectants on germination of fungal sclerotia was also tested as surviving structures of fungi are more resistant than the mycelium and the conidia. An effective disinfectant to control plant pathogenic fungi in greenhouses and winter storages of potatoes and vegetables was sought.

Material and methods

Disinfectants

A total of eight compounds (Table 1) were evaluated for their effectiveness in killing fungi in vitro. The concentrations used in the trials were those recommended by the manufacturers. Any deviations from these concentrations are specified in the tables. The disinfectants were diluted in water.

Test fungi

Eleven fungi, *Botrytis cinerea, Didymella bryoniae, Fusarium avenaceum* (only in cloth and wood surface tests), *F. culmorum, F. oxysporum, Mycocentrospora acerina, Phoma foveata, Phomopsis sclerotioides, Pythium* sp., *Rhizoctonia solani* and *Verticillium dahliae* from the collection of the Department of Plant Biology, Section of Plant Pathology (HPP), University of Helsinki, were tested against disinfectants in the vegetative phase. The age of inoculum was about three-four weeks. So the

mycelia and the spores were well developed, but there were no resting bodies except chlamydospores or microsclerotia in *F. oxysporum, M. acerina, P. sclerotioides* and *V. dahliae*. The effect of the disinfectants on the germination of sclerotia was also tested on *B. cinerea, R. solani, Sclerotium cepivorum, Sclerotinia sclerotiorum* and *Typhula* sp. The names of the fungi are mainly according to DOMSCH et al. (1980).

Cloth test

In the cloth test the fungi were grown on synthetic (nylon voile) gauze pieces (size approx. 1 x 1 cm) on PDA plates at room temperature in normal daylight. When visible fungal mycelium was spread from the inoculum plug to the cloth pieces on PDA surface, they were immersed in the test solutions for 5, 15, 30 and 60 min. After treatment the upper side of the fungi growing test material was placed upwards on PDA, each on a separate plate. The treatments were replicated five times with four plate per replicate. Sterile water was used as a control treatment. The plates were tabulated when the culture in the control treatment covered the entire plate. The results were evaluated on a rating scale of 0-2: 0=no growth, 1=growth inhibited, 2=growth like in the control treatment. The figures were converted to efficiency percentages.

Sclerotial test

With the exception of *Typhula* sp. which was grown at +5°C, the fungi were grown at room temperature on PDA plates to produce sclerotia. The sclerotia of *Rhizoctonia solani* were grown on cabbage pieces. The sclerotia (20 pcs) in a gauze bag were immersed in the disinfection solutions for 60 min. After treatment each sclerotium was placed on a plate of its own for evaluation of viability of the sclerotia. The results were evaluated when the control culture covered the entire plate.

Surface material

The tested surface materials were untreated pine, stainless steel and polyethene plastic discs. They were approx. 3 mm in thickness and approx. 1 cm in diameter. The discs were sterilized by autoclaving (wood and metal) or with 90% ethanol (plastic). The test fungi were grown on these surfaces as described above in the cloth test and immersed in the test solution for 30 and 60 min. The results were evaluated as + (fungal growth) or as - (no fungal growth). The figures in the tables are efficiency percentages.

The effect of organic material (peat and clay) on the disinfection efficiency was evaluated on polyethene plastic and steel surfaces. Plastic and steel discs approx. 1 cm in diameter and approx. 3 mm in thickness were used. The discs were contaminated with sterilized peat (15 g peat/5 dl water) and clay (80 g clay soil/8 dl water) suspension which was allowed to dry on the surface of the discs. The tests were carried out as described above in the surface material test except that the exposure time was 60 min.

Results

In the cloth test the most effective disinfectant was Desinfektol EL which completely inhibited the growth of all test fungi. Moderately effective disinfectants were also Iobac P, Menno-Ter-forte and NaOCl, although the growth inhibiting effect was not consistent in all fungi. Ipasept, Korsolin, Taloset and Virkon S (1%) were weak disinfectants (Table 2).

In the cloth test the disinfectants were very effective against *Pythium* sp. and moderately effective against mycelia of *Rhizoctonia solani*. Most fungi were, however, difficult to eradicate. These include e.g. *Verticillium dahliae* and *Mycocentrospora acerina*. A treatment time of 5 or 15 min was too short. The most effective treatment time was 60 min (Table 2).

Table 2. The effect of disinfectants on fungi growing on cloth pieces. Disinfectants: 1= Desinfektol EL, 2 = Iobac P, 3 = Ipasept, 4 = Korsolin, 5 = Menno-Ter-forte, 6 = NaOCl, 7 = Taloset, 8 = Virkon S.

Fungus	Disinfectant							
	1	2	3	4	5	6	7	8
	Minimum time min/efficiency %							
Botrytis cinerea	5/100	60/100	60/78	60/0	60/90	60/60	60/55	60/58
Didymella bryoniae	5/100	60/100	60/53	60/30	60/98	30/100	60/35	60/95
Fusarium avenaceum	5/100	60/100	60/55	60/38	60/75	60/98	60/60	60/63
Fusarium culmorum	5/100	60/100	60/13	60/0	60/65	15/100	60/60	60/73
Fusarium oxysporum	5/100	15/100	60/18	60/0	60/70	5/100	60/65	60/20
Mycocentrospora acerina	5/100	60/25	60/0	60/2	60/88	15/100	60/50	60/73
Phoma foveata	5/100	60/73	60/45	60/5	60/93	60/93	60/38	60/55
Phomopsis sclerotioides	5/100	60/80	60/68	60/65	60/98	60/98	60/63	30/100
Pythium sp.	5/100	5/100	15/100	15/100	5/100	5/100	5/100	5/100
Rhizoctonia solani	5/100	30/100	15/100	60/25	5/100	60/100	60/100	60/63
Verticillium dahliae	5/100	60/3	60/0	60/0	60/18	60/58	60/50	60/3

Table 3. The effect of disinfectants on the germination of sclerotia after 60 min treatment.

Disinfectant	Concentration %	*Botrytis cinerea*	*Rhizoctonia solani*	*Sclerotinia sclerotiorum*	*Sclerotium cepivorum*	*Typhula* sp.
		Efficiency %				
Desinfektol EL	Undiluted	100	–	100	–	–
Iobac P	3.0	5	8	5	50	10
	4.0	0	–	0	45	50
Ipasept	2.0	0	17	0	10	5
	3.0	0	–	0	35	0
Korsolin	1.0	0	8	0	0	5
	2.0	20	–	0	20	95
Menno-Ter-forte	1.0	15	75	0	75	100
	2.0	30	–	0	90	100
NaOCl	1.0	100	0	15	0	100
	2.0	–	–	8	0	–
	3.0	–	–	8	10	–
Taloset	1.0	0	–	0	–	-
	3.0	80	–	0	–	-
Virkon S	1.0	0	–	0	0	0
	2.0	20	17	0	0	100

In the sclerotial test Desinfektol EL inhibited the germination of *Botrytis cinerea* and *S. sclerotiorum* sclerotia. Menno-Ter-forte, NaOCl and Virkon S (2%) inhibited the germination of *Typhula* sclerotia. However, none of the disinfectants provided complete control over the sclerotia of *Sclerotium cepivorum* and *R. solani* (Table 3).

Wood surfaces were difficult to disinfest. Only Desinfektol EL inhibited completely the growth of *V. dahliae* and *R. solani*, NaOCl the growth of

Table 4. The effect of disinfectants on fungi growing on wood discs after 60 min treatment. Disinfectants: 1 = Desinfektol EL, 2 = Iobac P, 3 = Ipasept, 4 = Korsolin, 5 = Menno-Ter-forte, 6 = NaOCl, 7 = Taloset 3 %, 8 = Virkon S.

Fungus	Disinfectant							
	1	2	3	4	5	6	7	8
	Efficiency %							
Botrytis cinerea	0	0	0	0	0	100	0	0
Didymella bryoniae	0	60	0	0	0	0	0	0
Fusarium avenaceum	0	0	0	0	0	0	0	0
Fusarium culmorum	0	0	0	0	0	0	0	0
Fusarium oxysporum	0	0	0	0	0	0	0	0
Mycocentrospora acerina	0	0	0	0	0	0	0	0
Phoma foveata	0	0	0	0	0	0	0	0
Phomopsis sclerotioides	0	0	0	0	0	0	0	0
Pythium sp.	60	60	0	0	0	100	0	0
Rhizoctonia solani	100	0	0	0	0	0	0	20
Verticillium dahliae	100	0	0	0	0	0	0	0

Pythium sp. and *B. cinerea*. The other disinfectants were ineffective against the test fungi (Table 4).

The metal surface was effectively disinfested from fungi with Desinfektol EL and NaOCl. Menno-Ter-forte and Iobac P were effective against all test fungi except *V. dahliae* and *Phomopsis sclerotioides* (Table 5).

Organic material (peat and clay) did not reduce the efficacy of Desinfektol EL and NaOCl on metal surfaces. Iobac P and Menno-Ter-forte were also moderately effective on surfaces contaminated with peat. Peat did not reduce the efficacy of the disinfectants against *Pythium* sp, *R. solani, Fusarium oxysporum, F. culmorum* and *Phoma foveata* (Table 5).

Clay reduced most the efficacy of Ipasept, Korsolin, Menno-Ter-forte and Taloset on metal surfaces. *V. dahliae* and *B. cinerea* were difficult to eradicate. Inversely, metal surfaces contaminated with clay were easy to disinfest from *Pythium* sp. and rather easy from *D. bryoniae, F. culmorum* and *R. solani* (Table 5). Metal surfaces contaminated with clay were more difficult to disinfest than metal surfaces contaminated with peat.

The plastic discs were effectively disinfested from fungi with Desinfektol EL and NaOCl; slightly less effective disinfectants were Iobac P and Menno-Ter-forte. *Pythium* sp., *Mycocentrospora acerina* and *R. solani* were highly susceptible to disinfectants (Table 6).

The plastic discs contaminated with peat were most effectively disinfested with Desinfektol EL and Menno-Ter-forte; effective disinfectants were also Iobac P and NaOCl. Weak disinfectants were Ipasept, Taloset and Korsolin (Table 6). *Pythium* sp. and *P. foveata* were easy to eradicate, whereas *V. dahliae, P. sclerotioides* and *F. oxysporum* were not susceptible to disinfectants (Table 6).

Plastic pieces contaminated with clay were most effectively disinfested with Desinfektol EL. Most fungi were susceptible also to Iobac P, Menno-Ter-forte and NaOCl (Table 6). Easily eradicated fungi were *Pythium* sp., *P. foveata, D. bryoniae, B. cinerea* and *R. solani*, whereas *F. oxysporum, P. sclerotioides* and *V. dahliae* were difficult to eradicate (Table 6).

Discussion

In the laboratory tests of BÖHMER (1983), Menno-Ter-forte (0.5%) has been shown to inhibit the growth of *Fusarium oxysporum* conidia at 5 min treatment, but NaOCl (1%) did not inhibit the growth of the fungus. In the present laboratory tests, 70 % control was achieved over *F. oxysporum*

Table 5. The effect of disinfectants and organic material on fungi on metal surfaces. Treatment time 60 min. Disinfectants: 1 = Desinfektol EL, 2 = Iobac P, 3 = Ipasept, 4 = Korsolin, 5 = Menno-Ter-forte, 6 = NaOCl, 7 = Taloset 3 %, 8 = Virkon S.

Fungus	Organic material	Disinfectant							
		1	2	3	4	5	6	7	8
		Efficiency %							
Botrytis cinerea	Clean (N)	100	100	100	40	100	100	100	100
	Peat (P)	100	100	100	40	100	100	0	100
	Clay (C)	100	80	0	0	0	80	0	0
Didymella bryoniae	N	100	100	100	0	100	100	100	60
	P	100	100	100	0	100	100	40	60
	C	100	100	0	40	40	100	100	100
Fusarium culmorum	N	100	100	100	100	100	100	100	60
	P	100	100	100	100	100	100	100	60
	C	100	100	0	0	0	100	0	100
Fusarium oxysporum	N	100	100	100	100	100	100	100	0
	P	100	100	100	100	100	100	60	0
	C	100	100	0	0	40	100	20	60
Mycocentrospora acerina	N	100	100	100	40	100	100	100	100
	P	100	100	100	40	100	100	0	100
	C	100	80	20	0	20	100	40	80
Phoma foveata	N	100	100	100	100	100	100	60	100
	P	100	100	100	100	100	100	0	100
	C	100	80	40	0	60	100	20	100
Phomopsis sclerotioides	N	100	0	0	0	40	100	100	0
	P	100	0	0	0	40	100	60	0
	C	100	20	0	80	0	100	0	100
Pythium sp.	N	100	100	100	100	100	100	100	100
	P	100	100	100	100	100	100	100	100
	C	100	100	40	100	60	100	100	100
Rhizoctonia solani	N	100	100	100	80	100	100	100	100
	P	100	100	100	80	100	100	100	100
	C	100	80	40	40	60	100	100	100
Verticillium dahliae	N	100	0	0	0	40	100	0	20
	P	100	0	0	0	40	100	0	20
	C	100	20	0	0	0	100	0	0

with Menno-Ter-forte at 60 min treatment time in the cloth test, and NaOCl (1 %) controlled completely *F. oxysporum* after 5 min treatment in the cloth test.

The recommended concentrations of the disinfectant (e.g. Menno-Ter-forte) were shown to control the conidia of *F. avenaceum, F. culmorum, F. oxysporum* and *Verticillium dahliae* after 10 min treatment (BRIELMAIER 1985). In the present laboratory tests, Menno-Ter-forte did not kill *F. avenaceum* and *V. dahliae* after 60 min treatment. This is probably due to the fact the fungal cultures used in the trials contained in addition to conidia fungal mycelia and chlamydospores which are more resistant to disinfectants than the conidia.

In the laboratory trials of BAANDRUP (1983), Korsolin (2%) and Menno-Ter-forte (1%) inhibited the growth of *F. oxysporum* and *Pythium debaryanum* at 30 min treatment time. In the present trials, *Pythium* sp. was susceptible both to Korsolin (1%)

Table 6. The effect of disinfectants and organic material on fungi on plastic surfaces. Treatment time 60 min. Disinfectants: 1 = Desinfektol EL, 2 = Iobac P, 3 = Ipasept, 4 = Korsolin, 5 = Menno-Ter-forte, 6 = NaOCl, 7 = Taloset 3 %, 8 = Virkon S

Fungus	Organic material	Disinfectant							
		1	2	3	4	5	6	7	8
		Efficiency %							
Botrytis cinerea	Clean (N)	100	60	0	0	80	100	0	100
	Peat (P)	100	100	60	0	100	100	0	20
	Clay (C)	100	100	100	60	100	100	0	60
Didymella bryoniae	N	100	100	80	0	100	100	80	80
	P	100	0	0	0	100	100	20	0
	C	100	100	80	100	100	100	100	100
Fusarium culmorum	N	100	100	20	100	0	80	60	20
	P	100	100	0	20	100	100	0	80
	C	100	100	0	0	20	100	20	0
Fusarium oxysporum	N	100	100	0	0	100	100	0	20
	P	100	100	0	0	40	20	0	0
	C	100	60	0	0	0	0	0	0
Mycocentrospora acerina	N	100	100	100	100	60	100	100	80
	P	100	80	0	0	100	100	80	40
	C	100	40	20	0	100	100	0	40
Phoma foveata	N	100	80	100	0	100	100	100	80
	P	100	100	80	20	100	80	20	100
	C	100	100	100	100	100	100	0	100
Phomopsis sclerotioides	N	100	0	0	0	100	100	100	0
	P	100	0	0	0	20	80	0	0
	C	100	0	0	0	0	60	60	0
Pythium sp.	N	100	100	100	100	100	100	100	100
	P	100	100	100	100	100	100	40	100
	C	100	100	80	100	100	100	40	100
Rhizoctonia solani	N	100	20	100	100	100	100	100	100
	P	100	60	60	60	100	40	40	80
	C	100	100	80	100	100	100	60	80
Verticillium dahliae	N	100	0	20	0	80	100	0	0
	P	100	0	0	0	20	60	60	0
	C	100	0	40	0	80	40	0	0

and Menno-Ter-forte (1%) after 15 min treatment. The most effective disinfectants were Desinfektol EL and NaOCl. Desinfektol EL controlled all tested fungi. Effective disinfectants were also Iobac P and Menno-Ter-forte, whereas Ipasept, Korsolin and Taloset were weak disinfectants.

In the present tests, the disinfectants were most effective against *Pythium* sp. In Oomycetes the chemical composition of the cell wall is different from that of Deuteromycetes or Ascomycetes, which is probably the reason for the differences in efficacy between the fungal species. Also in other studies Oomycetes have been shown more susceptible to disinfectants than Deuteromycetes (BAANDRUP 1983). In an agar test carried out in Sweden, Korsolin (1%) and Menno-Ter-forte (0.5%) did not inhibit the growth of *Botrytis cinerea, Didymella bryoniae* and *Phomopsis sclerotioides* at 1 min treatment time (JOHANSSON 1985). In the present study, 60 min treatment time was too

short for Korsolin to kill the fungi, whereas for Menno-Ter-forte (1%) 60 min exposure time was quite sufficient to kill *D. bryoniae* and *P. sclerotioides*. The results show that Menno-Ter-forte requires at least 60 min exposure time and the concentration of compound should not to be lower than 1 %.

In the present study, the sclerotia of the fungi proved very resistant to disinfectants. None of the disinfectants provided complete control over the sclerotia of *Sclerotium cepivorum, Sclerotinia sclerotiorum* and *Rhizoctonia solani*. Only Desinfektol EL inhibited the germination of sclerotia of *B. cinerea* and *S. sclerotiorum* and NaOCl that of *B. cinerea* and *Typhula* sp. at 60 min treatment time. A treatment time of 60 min with Menno-Ter-forte (2%) did not prevent the growth of *S. sclerotiorum* although, according to BÖHMER (1985), soaking of sclerotia for 2 h in Menno-Ter-forte (1%) inhibited their growth. It is probably more important to use an exposure time of at least 2 h for sclerotial control than higher concentration. During the longer exposure time the disinfectant will penetrate deeper in the tissues of sclerotia than during a short exposure time. Desinfektol EL may be recommended to control sclerotia of *B. cinerea* and *S. sclerotiorum*, and NaOCl to control *B. cinerea* and *Typhula* sp. at one hour exposure time.

Fungi growing on wood surface were difficult to disinfest. Only Desinfektol EL controlled completely *V. dahliae* and *R. solani*, and NaOCl *Pythium* sp. and *B. cinerea*. Other disinfectants did not give complete control over the test fungi. Studies carried out in Sweden have shown that Iobac P (3 and 5%) and Menno-Ter-forte (1 and 5%) do not disinfest wood pieces infected with *Phoma* and *Fusarium* (BÅNG 1987). Also in this study Iobac P and Menno-Ter-forte were ineffective against *P. foveata, F. avenaceum, F. culmorum* and *F. oxysporum* growing on wood surface.

In the present study, Korsolin proved to be a weak disinfectant. It did not kill fungi growing on wood surface. Also in other studies (SUNDHEIM 1989) Korsolin has been shown ineffective against fungi growing on wood surfaces.

In studies carried out in Norway, Menno-ter-forte (5 %) has been effective on wood surface against *B. cinerea*, but ineffective against *P. sclerotioides* and *D. bryoniae* (SUNDHEIM 1989). In the present study, the recommended concentration (1 %) of Menno-Ter-forte was ineffective on wood surface against all test fungi. How long the fungus has grown on the wood surface will affect besides disinfectant concentration the efficacy of disinfection as the mycelium of fungi will partly grow in tree tissues, causing differences in test results.

The present study showed that organic material reduces the efficacy of most disinfectants. It is therefore important to clean thoroughly the surfaces before disinfection. In the laboratory tests, Desinfektol EL proved to be the most effective disinfectant on wood, steel and plastic surfaces contaminated with peat and clay. Not even organic material reduced the efficiency of the preparation. In the present study, the test fungi cultures were under one month old, and the viability of the conidia and the mycelia was very high. In practice the situation is very different, the fungal spores, mycelia and resting bodies in cold storages and greenhouses are not freshly grown, and the viability of pathogens has probably decreased. Thus, disinfectants with a wide effect on fungi e.g. NaOCl, Iobac P and Menno-Ter-forte can be used on steel and plastic surfaces although the efficacy is not perfect. For disinfection of wood surfaces, only NaOCl and Desinfektol EL, which were effective against some test fungi may be recommend. Also other limitations, such as safety and corrosivenes, may affect the choice of disinfectant to be used.

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SELOSTUS

Desinfiointiaineiden teho sieniin puhdasviljelmillä ja erilaisilla pintamateriaaleilla

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Tutkimuksessa testattiin kahdeksan desinfiointiaineen tehoa 11 sieneen. Kokeissa käytettiin useimmiten valmistajan suosittelemaa käyttöväkevyyttä. Kokeet tehtiin laboratoriokokeina liottamalla sientä sisältäviä kangaspaloja 5, 15 tai 60 minuuttia desinfiointiainelaimennoksessa. Desinfiointiaineiden tehoa tutkittiin myös puhtailla sekä savella tai turpeella liatuilla puu-, metalli- ja muovipinnoilla.

Tutkimuksissa todettiin, että viiden ja viidentoista minuutin vaikutusajat olivat useilla valmisteilla liian lyhyitä. Paras teho saatiin tunnin käsittelyllä. Kangaspalakokeissa kaikki tutkitut desinfiointiaineet tehosivat hyvin *Pythium*- sieneen. Valmisteista tehokkain oli Desinfektol EL. Myös NaOCl, Iobac P ja Menno-Ter-forte toimivat varsin hyvin useimpiin sieniin. Heikkotehoisin oli Korsolin.

Desinfiointiaineet tehosivat puupinnoilla huonommin kuin metalli- ja muovipinnoilla. Puukiekoilla kasvaviin *Rhizoctonia solani*- ja *Verticillium dahliae*- sieniin tehosi hyvin vain Desinfektol EL. NaOCl tehosi *Botrytis cinerea*- ja *Pythium* sp.-sieniin.

Metallipinnoilla tehokkaimpia valmisteita olivat Desinfektol EL ja NaOCl sekä melko tehokkaita Menno-Ter-forte ja Iobac P. Heikoin valmiste oli Korsolin. Vaikeita sieniä puhdistaa olivat *V. dahliae* ja *Phomopsis sclerotioides*. Helpoimpia sieniä hävittää olivat *Pythium sp., R. solani, B. cinerea, Fusarium* spp., *Mycocentrospora acerina* ja *Phoma foveata*.

Muovipinnalla kasvaviin sieniin paras valmiste oli Desinfektol EL. Myös NaOCl, Menno-Ter-forte ja Iobac P olivat hyviä. Heikoin valmiste oli Korsolin. Helpoimmin puhdistuivat *Pythium* sp. ja *R. solani*. Vaikeimpia sieniä olivat *V. dahliae* ja *P. sclerotioides*. Turve ja savi heikensivät useiden valmisteiden puhdistustehoa. Desinfektol EL:n ja NaOCl:n tehoa lika ei vähentänyt.