The effect of disinfectants on fungal diseases of cucumber

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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                         |
| Ibac 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 |
| Talosept       | 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 sclerotoides, Pythium sp. and Verticillium dahliae. The names of the fungi are according to 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 cul-
morum* 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, 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. sclerotioiodes* 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.

efficiency % = \( \frac{c - b}{a - b} \times 100 \)

- \( a \)= severity of infection in healthy control
- \( b \)= severity of infection in water control
- \( c \)= severity of infection in disinfection treatment.
Table 3. The effect of concentration and disinfection time on *Pythium* sp. in peat debris. Disinfectants and concentrations (N): 1 = formaline (5 %), 2 = Lobac 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 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------------|-------------------------|-----------|---|---|---|---|---|---|---|
| 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                       | -         | 92 | 100| 0  | 100| 16 | 67 |   |
|                              | 10                      | -         | 100| 100| 0  | 100| 63 | 92 |   |
|                              | 100                     | -         | 100| 100| 92 | 100| 91 | 100|   |
|                              | 100                     | -         | 100| 100| 100| 100| 100| 100|   |

One litre of inoculated sand was put into plastic pots and 60 ml (approx. 4 l/m²) 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. sclerotioidea* 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 | Disinfection time, min 100 | Efficiency % |
|-----------------|-----------------|---------------------------|---------------------------|--------------|
| Water           | 0               | 0                         | 0                         | 0            |
| Iobac P         | 1               | 83                        | 92                        | 0            |
|                 | 0.1             | 0                         | 0                         | 0            |
| Ipasept         | 2               | 100                       | 100                       | 0            |
|                 | 0.2             | 0                         | 0                         | 0            |
| Korsolin        | 2               | 100                       | 100                       | 0            |
|                 | 0.2             | 8                         | 0                         | 0            |
| Menno-Ter-forte | 1               | 100                       | 100                       | 0            |
|                 | 0.1             | 92                        | 42                        | 0            |
| NaOCl           | 0.1             | 75                        | 100                       | 0            |

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, Taloset and Virkon S were the weakest disinfectants (Table 6).

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

| Treatment       | Concentrations % | Didymella bryoniae 60/0 | Pythium sp. 60/50 | Verticillium dahliae 60/17 | Minimum time min/efficiency % |
|-----------------|-----------------|-------------------------|------------------|---------------------------|-------------------------------|
| Water           | 0               | 0                       | 0                | 0                         | 0/0/0                         |
| Formaline       | 5               | 15/100                  | 15/100           | 15/100                    | 15/100/60/92                 |
| Iobac P         | 3               | 15/100                  | 15/100           | 15/100                    | 15/100/60/83                 |
| Ipasept         | 2               | 60/58                   | 60/100           | 60/100                    | 60/100/60/100                |
| Korsolin        | 1               | 15/100                  | 60/92            | 60/92                     | 60/92/60/100                 |
| Menno-Ter-forte | 1               | 15/100                  | 60/100           | 60/100                    | 60/100/60/100                |
| NaOCl           | 10              | 15/100                  | 60/42            | 60/42                     | 60/42/60/58                  |
| Sanisept        | 2               | 15/100                  | 60/92            | 60/92                     | 60/92/60/75                  |
| Taloset         | 3               | 60/92                   | 60/75            | 60/75                     | 60/75/60/100                 |
| Virkon S        | 2               | 15/100                  | 60/75            | 60/75                     | 60/75/60/100                 |
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     | -       | 89     |
| Water               | 2.60 b  | 2.34 b  | -       | 96     |
| Formaline           | -       | 0.25 a  | -       | 92     |
| Iobac P             | 0.15 a  | 0.10 a  | 25      | -      |
| Ipasept             | 1.95 b  | -       | 94      | -      |
| Korsolin            | 0.20 a  | -       | 98      | 81     |
| Menno-Ter-forte     | 0.05 a  | 0.45 a  | 98      | 74     |
| NaOCl               | 0.05 a  | 0.60 a  | 98      | -      |
| Sanisep            | 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

Sanisep 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. Talolet 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 Talolet (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 sclerotioide* 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.

**** = P 0.001

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
were concentration the sand. 

Verticillium substrate in effective NaOCI mixed by a the peat. 

results effective plastic it laboratory also the debris on time against bryoniae. 

effect laboratory with influ-

Virkon experiment. 

minute (0.5%) V. expos-

Korsolin has only on Menno-Ter-forte 

V. peal pots. in greenhouse 

(1989) 

Menno-Ter-forte 

Phomopsis 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, NaOCI, 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 NaOCI 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 NaOCI 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, NaOCI and Virkon S were effective against V. dahliae in peat debris. Formaline and NaOCI 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, NaOCI and Virkon S. V. dahliae in sand substrate were eradicated most effectively by formaline and NaOCI. The effect of Iobac P and Desinfectol EL varied in different trials.

The results show that all the tested disinfectants

Virkon S, 2% Taloset NaOCI Menno-Ter-forte Iobac P Formaline Desinfektol EL Water Healthy control

Healthy plants, %

Test 1 Test 2

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 NaOCI 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. NaOCI, 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 in the paper test and Virkon S (1%) was ineffective. According to KOPONEN et al. (1992), many disinfectants (e.g. Menno-Ter-forte, NaOCI, 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 NaOCI 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 NaOCI 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, NaOCI and Virkon S were effective against V. dahliae in peat debris. Formaline and NaOCI 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, NaOCI and Virkon S. V. dahliae in sand substrate were eradicated most effectively by formaline and NaOCI. 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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Desinfiointiaineiden teho kurkun sienitauteihin

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

Laboratoriotesteissä testattiin valmisteiden suositeltujen käyttöväkevyyksien ja niistä tehtyjen laimennosten tehoa turpeessa tai kasvijätteissä oleviin taudinaheuttajiin. Lisäksi tutkittiin käsitelyajan vaikutusta valmisteiden tehoon. Kasvihuonetesteissä kasvatettiin kurkun taimia sienillä infektoidulla turpeella liatuissa, desinfioiduissa muoviruukuissa. Valmisteiden tehoa testattiin myös Phomopsis- ja Verticillium-sienillä infektoidun hiekkalustan desinfioinnissa. Pythium-sienen aiheuttama 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 kurkunmustajuurimäärin (Phomopsis sclerotioides) desinfioinnissa. Hieka-alustalla oleva sieni voitiin hävittää myös NaOClilla. Verticillium-sienen aiheuttama kurkunlakastumistauti torjuttiin parhaiten formaliinilla, Iobac P:lla, NaOCl:lla ja Virkon S:lla. Hiekan joukossa oleva taudinaheuttajan tehosivat formaliini ja NaOCl. Didymella bryoniae oli herkkä useimmille tutkituille desinfiointiaineille.

Desinfiointiakaksi suositellaan vähintään tunnin käsitelyaikaa, vaikka lyhyempikin aika laboratoriotesteissä saattoi antaa hyvän tuloksen.