Use of chemical disinfectants in mushroom production

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This factsheet examines the use of chemical disinfectants in mushroom production to prevent the spread of mushroom diseases. It is primarily a reference document, providing information on available products, their efficacy and important considerations affecting product choice. Legislation affecting use and disposal is also summarised.

MushTV

Factsheet **01/15**

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Key recommendations

- Debris from infected crops holds a severe risk of spreading diseases that can be transmitted by compost, such as *Trichoderma aggressivum* and Brown Cap Mushroom Virus (associated with Mushroom Virus X).
- New tests confirm that it is not possible to kill all mycelium in compost with disinfectants. Therefore, all compost, casing soil and any other organic matter must be removed before disinfecting a surface.
- Even high concentrations of biocides for prolonged periods cannot reduce pathogen populations to zero in compost.
- Follow the instructions on the label and always use the recommended personal protective clothing and equipment.
- There is no real alternative to steam cook-out to control mushroom diseases.
- Check what disinfectants are available for use in mushroom production in your country and choose the most effective disinfectant in combination with the lowest residue risk.
- Some disinfectants are corrosive and can reduce the lifetime of your equipment.
- Be sure to rinse extensively and remember that smoother surfaces are easier to disinfect and rinse.
- Thorough cleaning and disinfection lowers the disease risks associated with harvesting a third flush, particularly if combined with effective fly control.

1. Disinfection, in combination with an effective fly control programme, will lower the incidence of disease on your farm

What is a disinfectant?

Disinfectants are products intended to control unwanted micro-organisms such as algae, bacteria, fungi, viruses and also nematodes. In horticulture, they are specifically used to control micro-organisms on inanimate surfaces and objects such as compost floors, structures and equipment. They can also be useful in foot dips or mats, as a means of preventing disease transmission into high health status areas on the mushroom farm or compost yard.

Trichoderma aggressivum green mould and Brown Cap Mushroom Virus are potentially devastating diseases in mushroom cultivation. As there are no plant protection products available to control these diseases, an integrated approach towards control is needed. Hygiene is a key component of an integrated disease management strategy for fungal, bacterial and viral pathogens and should be carefully managed on compost yards, transportation vehicles and filling equipment, and on farm.

Cooking-out old crops

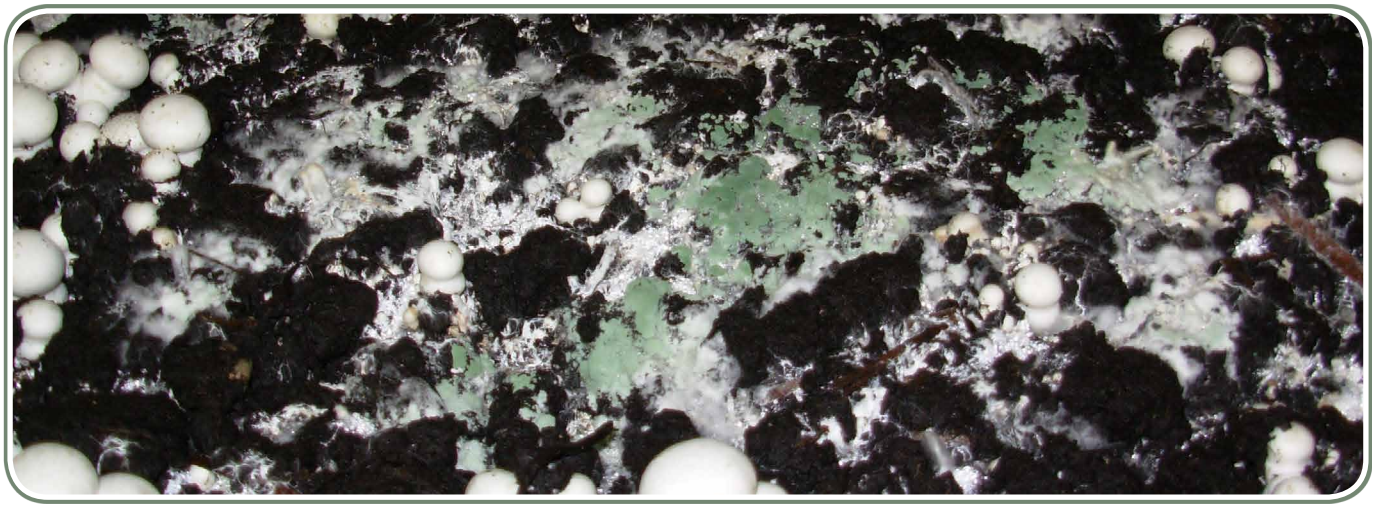
Disinfection alone is unlikely to provide effective, sustainable control of a disease. It is part of a hygiene programme which should consider processes, procedures and potential transmission routes throughout the production chain.

Many pathogenic micro-organisms, such as *Trichoderma* species and those causing Dry Bubble, Wet Bubble and Cobweb Disease, can survive on surfaces or in debris in the absence of a crop for several weeks or even months. When a new crop is introduced, there is a risk that reinfection will result. The aim of disinfection is to reduce the population of a damaging micro-organism to a level that no longer poses a threat to crop production. For some micro-organisms, such as highly infectious viruses, the aim will be to eliminate the virus from the mushroom farm completely. For more common micro-organisms such as bacterial pathogens, the aim will be to reduce the inoculum to a level at which it no longer causes infection in a normal, well-grown crop. The best way to kill all mushroom mycelium and pathogenic micro-organisms in an infected crop is by cooking-out. Steam cook-out should aim for 65-70˚C in the compost for a minimum of 8 hours.

Cleaning

Although steam cook-out gives the best protection, infections can be transmitted from one crop to another at any time. Cleaning is needed before disinfection because disinfectants cannot kill mycelium fragments in compost. Cleaning takes most of the infected material away and should be flushed into the drainage system where it is no longer a danger to new crops.

It requires a considerable but very necessary effort to maintain a high level of hygiene. The incentive for growers can be that this effort is balanced by a lower disease risk associated with harvesting a third flush.



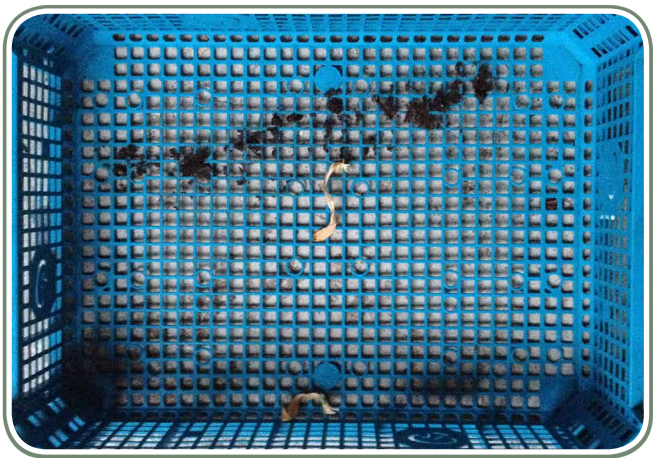
2. *Trichoderma aggressivum* can easily be spread with infected compost particles. It is important to clean them away. Disinfection of compost particles with biocides will not kill the organism

Areas of use

Disinfectants are most commonly used on compost yards, haulage trucks and filling equipment, and in mushroom farms for the treatment of surfaces and equipment. Areas and items that can be treated include:

- Empty growing rooms (floor, shelves, door handles).
- Workfloors, back doors and driveways.
- Nets and winches.
- Machines like the filling head, casing mixer, supplement mixer, ruffler machine, machines for mechanical harvest and conveyer belts.
- Picking aids, bins and baskets, harvesting knives and forklifts.
- Vehicle loading areas.
- Office, canteen and toilet doors and door handles.
- Mobile phones and computer keyboards.

Disinfectants should never be used on the mushroom crop itself. Disinfected surfaces should be rinsed thoroughly with water before being used, to reduce the risk of residue contamination. Rinsing may also be needed to lower the risk of damage by the corrosive action of some disinfectants.



3. Be sure to work with clean trays for harvest

4. Head filling machines should be cleaned thoroughly before use, as fragments of infected compost can cause problems

Considerations when choosing a disinfectant

Product label information

It is advised to check which products are registered for use in your country. There are considerable differences between EU member states about which products are registered for use in mushroom cultivation.

Chemical disinfectants specifically marketed for use in horticultural crop production usually carry detailed instructions on how the product should be used, covering a range of situations (as a spray, fog or dip treatment, for example). These should be carefully followed. It is suggested that intended users consult the distributor and/or manufacturer for guidance. Read the product label carefully and check that use in protected horticulture is not precluded.

Under the EU Biocidal Products Regulation 528/2012, it has become a legal requirement for all disinfectants to be regulation. This registration aims to ensure that biocidal products are sufficiently effective against target species and that claims are valid.

The label on products registered under the regulation will contain the following information:

- An authorisation number, eg HSE 1234.
- What the product is approved for; the product must not be used for any other purpose.
- Information about who is allowed to use it.
- Whether any protective clothing or equipment needs to be worn.
- How to use the disinfectant without harming yourself, other people or wildlife.
- Whether access to treated areas needs to be restricted.
- How to apply the biocide effectively.
- How to dispose of the product or empty container.

In the UK, at present (January 2015), none of the disinfectants commonly used in horticulture have been listed under the Biocidal Products and Chemicals Regulations 2013. Current products can continue to be used pending their review for inclusion and subject to relevant health and safety legislation.

Inactivation by organic matter

Most disinfectants are inherently reactive chemicals. Activity against any target pathogen will be severely reduced if the disinfectant reacts first with organic matter, such as peat, compost or mushroom debris. Some disinfectants (including hypochlorite and quaternary ammonium compounds, for example) are more susceptible than others to such loss of activity.

Wherever disinfectants are used, it is strongly recommended that the surface to be treated is first thoroughly cleaned of mushroom debris, peat, compost or any other organic contamination, as far as practicable, for example, by brushing, sweeping or washing the surface. Mushrooms leave a sticky biofilm on the surfaces they come into contact with. Biofilms are particularly difficult to remove and may require foam-based industrial cleaning agents.

Be careful when using a power washer to clean areas, as it will produce splashes and aerosols that spread across the areas you have already cleaned. When buying new equipment for compost yards or mushroom farms, choose equipment that is designed for easy cleaning.

Deposition of residues

Whenever you are using disinfectants, there is a risk of unintended contamination of your product. Quaternary ammonium compounds and phenolics, for instance, are known to leave residues, as will disinfectants containing silver. Therefore, it is prudent to choose disinfectants that are unlikely to leave residues. Hydrogen peroxide products and peroxyacetic acid break down into water, carbon dioxide and oxygen.

Corrosivity

Some disinfectants such as sodium hypochlorite and peracetic acid are known to be corrosive. Metal surfaces, such as aluminium, stainless steel and galvanized steel, are particularly prone to corrosion. Therefore, machinery may require different disinfectants compared to surfaces made of plastics, concrete, etc.

Health and safety

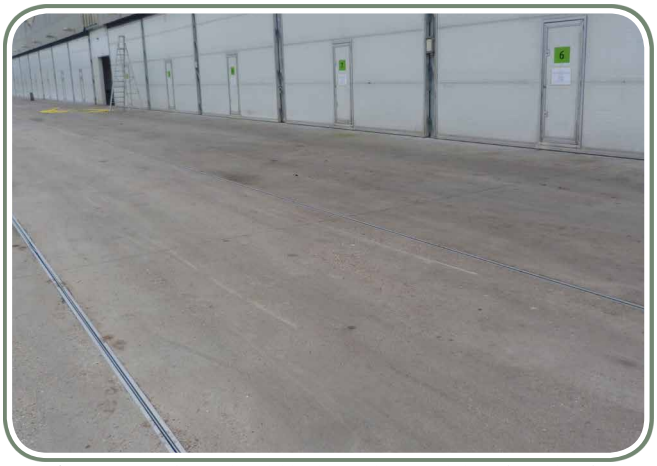
Most disinfectants are very reactive and some chemicals are caustic or damaging to mucous membranes or skin. Great care must, therefore, be exercised, particularly with the concentrated product. Follow the label instructions carefully and use the recommended personal protective clothing and equipment.

Measuring disinfectant concentration

The active ingredients present in cans of disinfectants may degrade over time (for example, hypochlorite based products). When in doubt, use a fresh can. On-site methods for measuring disinfectant concentration (such as test strips) are available for some products, including hydrogen peroxide and chlorine. Monitoring of solution pH is recommended for Menno Florades (based on benzoic acid), topping up as required to keep the solution pH below 4.5.

Other factors influencing activity

Disinfectant concentration, contact time and the level of organic matter contamination are likely to be the main factors influencing the activity of a given disinfectant against a particular micro-organism. However, check the product label carefully as other factors such as temperature, pH and water hardness may also have a significant influence. Some disinfectants are combined with detergents which have good wetting powers and increase contact with surfaces.



5. The compost floor should be kept clean and disinfected before filling a room

Types of disinfectant

Disinfectants can be grouped according to the chemical structure and mode of action of their active ingredients. A full overview is given in HDC Factsheet 03/14. The predominant disinfectants used in the mushroom industry are likely to be either chlorine based (sodium hypochlorite), hydrogen peroxide, peracetic acid (or combinations of hydrogen peroxide and peracetic acid), phenolics or quaternary ammonium compound based (or mixtures of quaternary ammonium compounds and aldehydes, such as glutaraldehyde). The key features of each of these groups of active ingredients are summarised below. Note that some of the products contain active ingredients from more than one class.

Cationic surfactants – quaternary ammonium compounds

Quaternary ammonium compounds (QACs) are non-corrosive and non-irritating disinfectants. They have good penetrating activities when combined with a wetting agent. Their effects on micro-organisms are varied and selective, however, and they tend to foam and leave a residue, though some current products are less prone to this problem. They are usually more effective on bacteria and may have little or no effect on fungi. They may be less active in the presence of organic matter, oils and waxes. They can be expensive.

Halogens and halogen-releasing compounds – chlorine based

These relatively inexpensive materials release chlorine when activated. Chlorine has broad-spectrum activity against viruses, bacteria, yeasts and moulds, though activity is slower against spores. Chlorine-based compounds are effective at cool temperatures and are unaffected by hard water properties. They have only a short residual effect, precipitate in iron-laden water and may be very corrosive. In addition, the biocidal efficacy is strongly reduced in the presence of organic materials (such as compost).

Oxidising agents – peroxides

Peroxides have broad-spectrum activity against viruses, bacteria and fungi, including spores. They are effective in cold conditions and in the presence of organic contamination. Hydrogen peroxide products (which are formulated with acetic and peracetic acid) and peracetic acid are both environmentally benign, breaking down into water, carbon dioxide and oxygen. Some products also contain silver which is claimed to provide some residual disinfectant activity on the treated surface.

Phenol – high boiling (point) tar acids (HBTA)

These products are derived from tar acids by distillation. They are acidic disinfectants with a low pH and have a broad spectrum of activity against viruses, bacteria, fungi and mycoplasmas. They are effective at low temperatures and in the presence of organic matter. HBTA phenols are potent biocides but they can have strong odours and may be corrosive to plastic and rubber. There is a risk of taint and residues if used where edible crops are grown.

Phenol – synthetic phenols

Synthetic phenols avoid some of the odour and staining problems of HBTA phenols. They are also neutral rather than acid. However, they are not as broad spectrum in activity as HBTA phenols and there are some question marks about their environmental safety. There is a risk of taint if used where edible crops are grown.

Reducing agents – aldehydes

Glutaraldehyde is the most important reducing agent used as a disinfectant. Aldehydes have a broad spectrum of activity but need a long contact time for disinfection. Their action is temperature dependent. There are potential health hazards to operators from exposure.

Efficacy against virus-infected *Agaricus bisporus* and *Trichoderma aggressivum*

The ability of various disinfectants to suppress virus-infected mycelium of *Agaricus bisporus* and *Trichoderma aggressivum* was tested in the MushTV project. Efficacy was tested under laboratory conditions on spores, mycelium and compost particles. Such tests represent disinfecting capabilities under the best conditions possible. The results are summarised in Tables 1 and 2.

A comparison of the different disinfectants shows that they are not equally effective. The results show it is very hard to kill an organism while present in compost particles. Disinfectants that are effective against basidiospores and mycelium of *Agaricus bisporus* are, in general, much less effective when this organism is present within compost. *Trichoderma aggressivum* was not killed by any of the disinfectants while present in infected compost particles.

Gaseous ozone was tested as a possible disinfectant for entire rooms but did not show enough efficacy against the organisms tested. The organic acid tested proved to be effective but required very long contact times at a sufficiently low pH.

The efficacy of two disinfectants on surfaces commonly encountered in mushroom cultivation was also evaluated in a practical situation. For this, we selected Jet 5 (peracetic acid) and EcoChlor (hypochlorite based) as these disinfectants were shown to be effective and less likely to leave residues. These disinfectants were used on a rubber surface, stainless steel, a net in the growing room, a net in the tunnel, a concrete floor, an insulation panel, on coated steel and on aluminium. All surfaces were contaminated with either basidiospores of *Agaricus bisporus* or conidiospores of *Trichoderma aggressivum*. Both disinfectants showed good efficacy, killing more than 85-90% of the spores applied. In general, disinfection was more efficient on smooth surfaces. It is not possible to rely solely on disinfectants – cleaning and other hygiene measures still remain important.

Table 1. Summary of disinfectant efficacy against *Agaricus bisporus*, as determined in the MushTV project

Product	Class or sub-class	Conc.	*Agaricus bisporus* basidiospores		*Agaricus bisporus* mycelial fragments		*Agaricus bisporus* colonised compost	
			15 min.	60 min.	15 min.	60 min.	15 min.	60 min.
Formalin	Reducing agents – aldehydes	2%	+	+++++	++++	+++++	+++++	++++
		4%	+++++	+++++	++++	+++++	+++++	++++
Jet 5	Oxidising agents – peroxides	1%	+++++	+++++	++++	+++++	-	-
		2%	+++++	+++++	++++	+++++	+	+
Eco-Des	Cationic surfactants – quaternary ammonium compounds	2%	+++++	++	+++++	+++++	++	++++
		4%	-	++	+++++	+++++	+++++	++++
Eco-Chlor	Halogens and halogen-releasing compounds – chlorine based	2%	+	++++	+++++	+++++	-	-
		4%	+	++++	+++++	+++++	-	-
Virocid	Cationic surfactants – quaternary ammonium compounds & Reducing agents – aldehydes	0.5%	+++++	+++++	+++++	+++++	-	+
		1%	+++++	+++++	+++++	+++++	+	++
Neuthox 75	Oxidising agents – (electrochemically activated water)	4%	++++	+++++	-	-	-	-
		8%	+++++	+++++	++	++	-	-
Prophyl	Phenol – synthetic phenols	0.5%	+++++	+++++	+++++	+++++	++++	++++
		1%	+++++	+++++	+++++	+++++	++++	++++
Gaseous ozone[e]	Oxidising agents	50 ppm	-[a]	-[b]	++++ [a]	++++ [b]	- [a]	- [b]
		100 ppm	+[a]	++ [b]	+++++ [a]	+++ [b]	- [a]	- [b]
Menno Clean	Organic acids – aromatic acid	2%	+++++[c]	+++++[d]	+++++ [c]	+++++ [d]	++++ [c]	++++ [d]
		4%	+++++ [c]	+++++ [d]	+++++ [c]	+++++ [d]	++++ [c]	+++++ [d]
Tersan	Cationic surfactants – quaternary ammonium compounds Alkali – hydroxides	1%	+++	+++	+++++	+++++	-	-
		2%	+++	+++	+++++	+++++	-	+

Key: - no effect/no reduction in fungal growth; + 1-25% reduction; ++ 26-50%; +++ 51-75%; ++++ 76-99%; +++++ no fungal growth. Results presented are generally for 15 or 60 minutes exposure time, except for:

[a] Instead of 15 min total disinfection time; 40 min.

[b] Instead of 60 min total disinfection time; 80 min.

[c] Instead of 15 min total disinfection time; 3 hours.

[d] Instead of 60 min total disinfection time; 6 hours.

[e] Treatment with gaseous ozone was performed at an average temperature of 19.6°C (min 19.5/max 20.0) and an average relative humidity of 71.3% (min 58.0/max 77.5).

The level of disinfectant activity in an experiment is affected by the concentration used, contact time, the level of organic matter contamination, the nature of the test procedure and other factors.

Results shown in this table have been obtained in laboratory tests under optimal disinfecting conditions to test efficacy. In practical situations efficacy will be lower. It is advised to check which products are registered for use in your country.

Table 2. Summary of disinfectant efficacy against *Trichoderma aggressivum*, as determined in the MushTV project

Product	Class or sub-class	Conc.	*Trichoderma aggressivum* conidiospores		*Trichoderma aggressivum* mycelial fragments		*Trichoderma aggressivum* colonised compost	
			15 min.	60 min.	15 min.	60 min.	15 min.	60 min.
Formalin	Reducing agents – aldehydes	2%	+++++	+++++	+++++	+++++	-	-
		4%	+++++	+++++	+++++	+++++	-	-
Jet 5	Oxidising agents – peroxides	1%	+++++	+++++	-	-	-	-
		2%	+++++	+++++	+++	+++	-	-
Eco-Des	Cationic surfactants – quaternary ammonium compounds	2%	+++++	+++++	+++++	+++++	-	-
		4%	+++++	+++++	+++++	+++++	-	-
Eco-Chlor	Halogens and halogen-releasing compounds – chlorine based	2%	+++++	+++++	+++++	+++++	-	-
		4%	+++++	+++++	+++++	+++++	-	-
Virocid	Cationic surfactants – quaternary ammonium compounds Reducing agents – aldehydes	0.5%	+++++	+++++	+++++	+++++	-	-
		1%	+++++	+++++	+++++	+++++	-	-
Neuthox 75	Oxidising agents - (electrochemically activated water)	4%	+++++	+++++	-	-	-	-
		8%	+++++	+++++	-	-	-	-
Prophyl	Phenol – synthetic phenols	0.5%	+++++	+++++	++	++	-	-
		1%	+++++	+++++	+++	+++	-	-
Gaseous ozone[e]	Oxidising agents	50 ppm	- [a]	- [b]	- [a]	- [b]	- [a]	- [b]
		100 ppm	- [a]	- [b]	- [a]	- [b]	- [a]	- [b]
Menno Clean	Organic acids – aromatic acid	2%	+++++ [c]	+++++ [d]	+++++ [c]	+++++ [d]	- [c]	- [d]
		4%	+++++ [c]	+++++ [d]	+++++ [c]	+++++ [d]	- [c]	+++ [d]
Tersan	Cationic surfactants – quaternary ammonium compounds Alkali – hydroxides	1%	+++++	+++++	+++	+++	-	-
		2%	+++++	+++++	+++	+++	-	-

Key: - no effect/no reduction in fungal growth; + 1-25% reduction; ++ 26-50%; +++ 51-75%; ++++ 76-99%; +++++ not detected.

Results presented are generally for 15 or 60 minutes exposure time, except for:

[a] Instead of 15 min total disinfection time; 40 min.

[b] Instead of 60 min total disinfection time; 80 min.

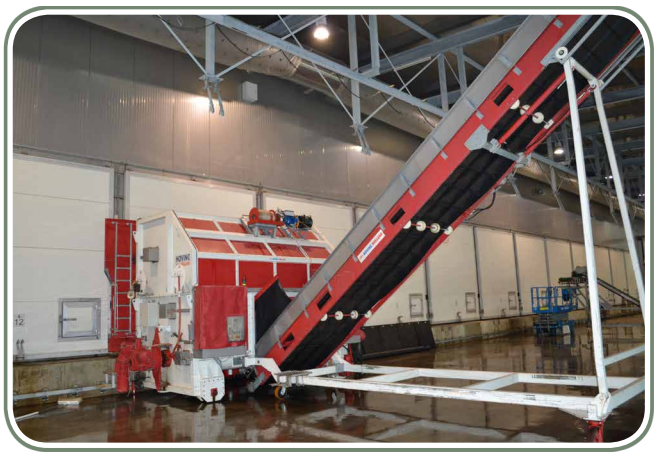
[c] Instead of 15 min total disinfection time; 3 hours.

[d] Instead of 60 min total disinfection time; 6 hours.

[e] Treatment with gaseous ozone was performed at an average temperature of 19.6°C (min 19.5/max 20.0) and an average relative humidity of 71.3% (min 58.0/max 77.5).

The level of disinfectant activity in an experiment is affected by the concentration used, contact time, the level of organic matter contamination, the nature of the test procedure, and other factors.

Results shown in this table have been obtained in laboratory tests under optimal disinfecting conditions to test efficacy. In practical situations efficacy will be lower. It is advised to check which products are registered for use in your country.



6 & 7. Clean equipment, ready for emptying tunnels

Residue levels were measured both after washing/rinsing away the disinfectant and without washing away the disinfectant. If the surface was rinsed, residues of hypochlorite disappeared within an hour. Residues of peracetic acid disappeared slowest on the rubber surface and took less than four hours. If the surface was not washed, residues of hypochlorite or peracetic acid disappeared within four hours. Residues disappeared slowest on rubber surfaces.

It is advised to check which disinfectants are registered for use in your country.

EU Biocidal Products Regulation (528/2012)

The use of disinfectants in Great Britain from 1 September 2013 is now regulated by the Biocidal Products and Chemicals Regulations 2013; these regulations enforce the EU Biocides Regulation 528/2012.

Previously, the EU Biocidal Products Directive (BPD) 98/8/EC, which came into effect in May 2000, laid down harmonised rules for placing biocidal products on the market. Relatively few disinfectants were assessed and registered under this legislation. The EU Biocidal Products Regulation 528/2012 repealed and updated the BPD. The same basic framework applies with active ingredients approved at EU level and products approved at national level. Its main purpose is to improve the free movement of biocidal products within the EU, while maintaining the high level of protection of human and animal health and the environment, established in the BPD. Transitional arrangements are provided for existing biocidal products.

There are 22 different product types. Disinfectants used in commercial mushroom production are likely to fall into:

- Product-type 2 ('Disinfectants and algaecides not intended for direct application to humans or animals').
- Product-type 4 (Food and feed area disinfectants).

Product-type 2 biocides are due to be listed in the Union list from 1 January 2017.

In Great Britain, a few disinfectants are registered as pesticides (eg benzoic acid) or commodity substances (eg sodium hypochlorite). Pending review for inclusion in Annex 1/1A/ Union list, such products will continue to be approved until they have been reviewed.

As a result of this transitional phase, there are currently differences between the EU member states with respect to current registration of biocides. Information registration can be obtained from your supplier and/or found on the websites of the authorities concerned with registration in the member states, as follows:

Belgium: http://www.favv-afsca.be/autocontrole-nl/informatie/toegelatenbiociden/.

The Netherlands: http://www.ctgb.nl/.

Ireland: http://www.pcs.agriculture.gov.ie/biocides/

United Kingdom: http://webcommunities.hse.gov.uk/connect.ti/pesticides/view?objectId=6020

Poland: Biocides registered for use in the mushroom industry have been published in the magazine 'Pieczarki' (dr J. Szumigaj-Tarnow, M. Sc. Zbigniew Uliński and Dr M. Lewandowski. (2014) Terminarz ochrony pieczarki na lata 2014-2015. Pieczarki 2, pp. 10-18).

Sustainable use of pesticides

Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009, established a framework for Community action to achieve the sustainable use of pesticides (including biocides) and is more commonly referred to as the 'Sustainable Use Directive'. Article 14 of this directive states that EU Member States shall take all necessary measures to promote low pesticide-input pest management, giving wherever possible priority to non-chemical methods, so that professional users of pesticides switch to practices and products with the lowest risk to human health and the environment among those available for the same pest problem. Low pesticide-input pest management includes integrated pest management and application of biocides. EU Member States must describe in their National Action Plans how they ensure that the general principles of integrated pest management, as set out in Annex III, are to be implemented by all professional users by 1 January 2014.

Human health at work

Handling and application of pesticides (including biocides) requires the setting of minimum health and safety requirements at the workplace, covering the risks arising from exposure of workers to such products, as well as general and specific preventive measures to reduce those risks. Those measures are covered by Council Directive 98/24/EC of 7 April 1998, on the protection of the health and safety of workers from the risks related to chemical agents at work and Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004, on the protection of workers from the risks related to their exposure to carcinogens or mutagens at work. The different EU member states have national laws to reduce the risk of substances to human health at work. The product label will give guidance on how to use the disinfectant without harming yourself, other people or wildlife and tell you whether any protective clothing or equipment needs to be worn.

COSHH

In the UK, the Control of Substances Hazardous to Health (COSHH) Regulations are now well established to reduce the risk of substances to human health at work. The sixth edition of the Code of Practice was updated in 2013 and can be downloaded from:

http://books.hse.gov.uk/hse/public/saleproduct.jsf?catalogueCode=9780717665822.

All the disinfectants mentioned in this factsheet and others which may also be used on farm, will be controlled by these regulations. Keep on file and read:

- The product label.
- The product material safety data sheet (sometimes called the material safety data sheet).

These are available as downloads from the manufacturer and give essential guidance on protective clothing and possible use in horticultural applications. The acquisition of safety data sheets is a requirement of a COSHH assessment.

Disposal of waste disinfectant solution

Waste disposal is tightly regulated. Reduce or eliminate the need for disposal by only making the quantity of disinfectant solution needed. It may be possible to reuse diluted disinfectant for a lower-grade purpose such as non-critical rinsing.

Disinfectants carry an environmental threat at disposal and are classed as trade effluent, which may need a licence from the competent authorities for discharge from the premises.

The product label will identify safe methods for disposing of surplus disinfectant and the empty container.

Further information

MushTV Factsheets

02/15; Brown Cap Mushroom Virus (associated with Mushroom Virus X) prevention

03/15; Understanding *Trichoderma aggressivum* in Bulk Phase 3 compost

04/15; Fungal diseases of mushrooms and their control

HDC Factsheets and publications

03/14; Use of chemical disinfectants in protected ornamental plant production

10/08; Identification and control of Cobweb Disease on mushrooms

09/08; Identification and control of Dry Bubble Disease of mushrooms

HDC Grower summaries and reports

See the HDC website (www.hdc.org.uk) for copies of M 57 and information on the MushTV project.

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