Choice of disinfectant crucial for optimal hygiene

Greenhouse clean-out crucial for year long health and harvest

The upcoming clean-out offers the chance to optimise hygiene in the greenhouse. The choice of the correct protocol and the right disinfectant are crucial.

The correct protocol is clear and simple. First clean then disinfect. Proper cleaning reduces 80% of possible infections. Cleaning in combination with a good detergent can bring this up to 98%. Cleaning must be followed by disinfection. This is of utmost importance to remove the remaining & stubborn micro-organisms. Not only must surfaces be disinfected, but most crucially the water distribution systems and drippers.

Example of "crazy roots" in tomato culture. Using the correct disinfectant will significantly control this problem.

Biofilm

The main source of micro-organism pollution in a greenhouse is the biofilm present in the water distribution system. A definition of biofilm is: *A biofilm is an aggregate of microorganisms in which cells adhere to each other on a surface. Bacteria in biofilms are much more resistant to toxic substances such as antibiotics and detergents.* (Wikipedia)

The main property of bacteria in biofilms is there extremely high resistance and aggressiveness. Bacteria in biofilms are 10 to 1000 times more resistant to disinfectants than 'free swimming' bacteria of the same species that do not arise from biofilm. Bacteria in biofilm form the most persistent hygiene problem in the greenhouse and the greatest source of disease. (Prosser, B. L. et al. (1987); Nickel, J.C. et al.(1985); Gristina, A.G. et al. (1987); Evans, R.C. and Holmes, C.J. (1987)).

Micro-organisms in biofilm are very aggressive and resistant and form a continuous source of contamination for plants (y. Pachepsky; J. Morrow; A. Guber; D. Shelton; R. Rowland; G. Davies; 2012). It is therefore of major importance to prevent biofilm and destroy micro-organisms in irrigation water. Biofilm has a negative impact on the growth and harvest of crops – Yes biofilm costs money! The continuous supply of aggressive and resistant micro-organism to plants means that plants spend a considerable amount of their energy fighting off these constant attacks by micro-organisms - energy that could otherwise be used in growth and production. For optimal crop hygiene and production the biofilm must be removed.

Possible solutions

There are a number of disinfectants on the market, but not all are equally suited for optimum greenhouse hygiene:

a) Chlorine
b) Acid
c) hydrogen peroxide, whether or not combined with an acid
d) Loxyde

a) Chlorine

Chlorine can be a good disinfectant when used under the right circumstances. It is also an excellent bleaching agent.

Chlorine should not be continuously applied. This is because micro-organisms rapidly develop resistance to chlorine (H.F. Ridgway; B.H. Olson; 1982 & Rodney m. Donlan and j. William Costerton, 2002). The water's pH is also highly important. Chlorine works optimally at a pH between 6 and 7.5. Outside of this range its effect rapidly decreases. The environmental impact of chlorine is relatively high. The formation of toxic reaction by-products such as Trihalomethanes (THM) is unwanted. Furthermore chlorine is extremely corrosive.

Scientific research shows that chlorine is barely effective in breaking down biofilm. (Dirk de Beer; Rohini Srinivasa; Philips Stewarts; 1994). In addition, chlorine has no positive effect on plant growth – small overdose can do hefty damage.

The use of chlorine has some important disadvantages for horticulture production. It is not the optimum disinfectant for the control of biofilm, the greatest hygiene problem in the greenhouse.

b) Acid

Acid is an excellent product for removing inorganic pollution such as mineral salts and calcium. It also has an effect on micro-organisms. The effect on the organic biofilm (the bulk of the biofilm) is non-existent. Acid is good to use in combination with hydrogen peroxide. First apply the acid and follow this up with a minimum of 5% hydrogen peroxide.

c) Hydrogen peroxide (in combination with acid)

Hydrogen peroxide is a very good disinfectant for horticulture. It kills almost all micro-organisms, is fairly insensitive to pH, builds no resistance and has a very good effect on biofilm.

Disadvantage of hydrogen peroxide is the chain reaction. Once it comes into contact with organic matter the reaction of the hydrogen peroxide cannot be stopped. This makes the use of hydrogen peroxide relatively inefficient and short-lived. After twenty minutes the product is all used up.

Adding acid (e.g.: peracidic acid) to hydrogen peroxide has no influence on the duration of the reaction. It does make the reaction stronger, but it remains relatively inefficient. During continuous use, one can see the range decreasing.

d) Loxyde

Loxyde is a stabilised & activated hydrogen peroxide. In the stabiliser is also an activator that strengthens the effect of the peroxide. The stabiliser ensures long-term effectiveness and prevents the chain reaction as with normal hydrogen peroxide. This allows Loxyde to be effective for up to 170 hours. It is fairly insensitive to pH and temperature and no more corrosive than water.

Loxyde is very effective against micro-organisms and biofilm. It can be dosed in a concentration of 0.5-2% to clean the pipes and drippers of biofilm. This will also destroy all micro-organisms and unlike normal hydrogen peroxide, Loxyde is effective against spores.

Loxyde is also very effective in continuous dosage (20-50 ml/m^3 of water) to prevent against micro-organisms and biofilm. Another advantage is that overdose will not cause any direct damage. Plants also make hydrogen peroxide, making it a well-known substance for plants. As a result, they are better able to respond to hydrogen peroxide than, for example chlorine.

In continual dosage systems Loxyde is always present throughout the entire watering system and will attack any micro-organism that reveals itself as well as prevent biofilm formation. This is very important to prevent disease such as for instance "crazyroots" (*Agrobacterium*). Loxyde users with "crazyroots", report that infection significantly decrease after the yearly clean-up (e.g.: from 20% down to 1%) and that it remains stable during the entire year. Another greenhouse practice test (2 x 6 Ha) showed "crazyroots" to continue to spread in chlorinated water whereas in Loxyde treated water there was no "crazyroot"infection. Another example is on strawberry crops where continual dosage increased production between 10-50%!

Conclusion:

It is very important to use the right disinfectant for the right problem. In the Netherlands all disinfectants mentioned here above had to undergo very strict disinfectant protocols to prove their efficacy against a range of micro-organisms in order to be admitted as disinfectants. However achieving required disinfection protocol does not necessarily mean a particular disinfectant is suited to a specific task.

For the specific problems of general hygiene as well as biofilm hygiene in greenhouse irrigation systems it is crucial to examine the suitability of the proposed disinfectant and make the right choice as to which product can deliver the best hygiene results for each particular application. Not only for the period directly following the clean-up but also during the entire growing season.

The purchase price of a product can be a decisive factor in the short term. However in the long term it can reveal itself to be a costly saving resulting in higher costs (e.g.: pesticides) and lower production. The choice of the right product at the right time for the right problem is crucial.

The yearly clan-up is the ideal moment to properly remove biofilm. This offers important benefits throughout the coming season. The right approach and product is ultimately cost effective and will eventually result in higher production & lower costs.

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