

Hydrogen peroxide for cleaning irrigation system

Elly Nederhoff

CropHouse Ltd, New Zealand

Elly@CropHouse.co.nz

Published in the Commercial Grower 55(10), 2000, p. 32-34

Hydrogen peroxide is not suitable for root disease control in nutrient solutions of soilless cultures. This was the outcome of a research project funded by the Vegfed Fresh Vegetable Sector reported in the Grower of October 2000. Pathogen control in water requires at least 100 ppm of hydrogen peroxide. Levels of 85 - 100 ppm nearly killed young lettuce seedlings, while 8-12 ppm reduced growth of hydroponic lettuce plants. Hydrogen peroxide can be used, though, for disinfection of isolated batches of water, or for making and keeping the irrigation system clean. This article describes the technical features of hydrogen peroxide and recommendations of how to use it for those latter purposes.

Hydrogen peroxide

Hydrogen peroxide (H_2O_2) is a clear and colourless liquid with a slightly pungent odour. It is heavier than water and can be mixed with water. It is non-flammable but in higher concentrations it supports combustion. If not handled properly concentrated solutions are highly dangerous. The active part of hydrogen peroxide is the peroxide, which is an oxidant similar to ozone and chlorine. Hydrogen peroxide added to (dirty) water quickly breaks down into water and an oxygen atom. This can be extremely reactive and it oxidises anything including organic matter and metal ions. Peroxide kills pathogens (disease-causing organisms) and also damages plant cells.

Hydrogen peroxide solutions need to be stabilised, which is usually done by adding a weak organic acid. The pH value of commercial available hydrogen peroxide can be between 1.5 and 3. Most suppliers sell stabilised solutions of 35%, 50%, 60% or 70%. There are also products that contain a trace of silver or copper. The manufacturers claim that these metals have an effect in itself against micro-organisms, but the benefits of added silver or copper are not proven. Hydrogen peroxide is sustainable and environmental friendly. It does not leave a chemical residue like chlorine does, so flushing and rinsing is not needed.

Concentration (ppm)

The dosage is expressed as parts per million (ppm), which equals gram per m^3 water (g/m^3). Most growers measure a liquid by volume rather than by weight. But unlike water, 1 milliliter of hydrogen peroxide solution is not the same as 1 gram, and the specific weight depends on the concentration. Pure hydrogen peroxide weighs 1.45 gram per ml; 50% solution weighs 1.20 gram per ml; and 35% weighs 1.13 gram per ml (the specific weight is written on the container). This makes working with milliliters rather complicated, as shown by the following example. One ppm equals 1 g pure hydrogen peroxide added to 1 m^3 of water. Thus 15 ppm equals 15 g pure hydrogen peroxide, which equals 10 ml ($15/1.45 = 10$ ml) per m^3 water. If we use a 50% hydrogen peroxide solution we need about double the amount: 30 g, which equals 25 ml ($30/1.2 = 25$) per m^3 water. When using 35% solution we need about triple the amount: 45 g or 40 ml ($45/1.13 = 40$) per m^3 water to get the same concentration. Some growers assume that 1 ppm equals 1 ml per 1 m^3 , but this causes a considerable inaccuracy in the concentration.

Measuring hydrogen peroxide

It is wise to measure the concentration of hydrogen peroxide, especially in a recirculating nutrient solution, and to check the break-down or build-up of hydrogen peroxide. At present, the only practical measuring method available is test strips for hydrogen peroxide (e.g. Merck or Quantofix).

Pathogen control in soilless cultures - part 9

They change colour when dipped in a solution with peroxide, and the colour is compared with a reference chart. There are two types, one for the low range of 0.5-25 ppm, and one for 5-100 ppm. The test strips are about \$1 for each strip for one-off use. It is also advisable to watch the roots after a peroxide dose. If the roots suddenly get brown or if they die, obviously the peroxide dose was too high.

Disinfecting batches of water

Hydrogen peroxide can be applied to a batch of water in a separate tank where the peroxide cannot come in contact with the plants. A level of 500 ppm is effective against tough pathogens such as nematodes. After the reaction time the peroxide needs to disappear, which can take a while when there is little organic matter in the water. This water treatment is quite costly due to the considerable volumes of hydrogen peroxide needed and the investment in water storage tanks. The advantage is that it can be safer to use than chlorine and it leaves no residue, and that is why growers use it.

Cleaning irrigation system

Irrigation lines and drippers can get blocked by algae, bacteria, fungi, iron and fertilisers. Without plants the irrigation system can be cleansed by chlorine and/or acids, which must be thoroughly rinsed out before planting. Another approach is to use a low dose of hydrogen peroxide when the plants are in the system. A certain dose of hydrogen peroxide must be used that is just effective and just mild enough for plants. Control of algae requires 50 ppm or more. Alternatively, one can use a lower dose for a longer period of time (months). Before planting, the system must be cleaned as good as possible by rinsing, flushing, blowing or vacuuming. Hydrogen peroxide can be added to the nutrient tank automatically using a plunger pump, or it is added to the tank once a day before the last irrigation cycles. The lines are full with the peroxide solution during the night, and most peroxide has disappeared when irrigation starts again in the morning.

Influence of growing medium

The type of growing media indirectly has an effect on the use of hydrogen peroxide. An organic substrate contains ample organic material that inactivates the peroxide. An anorganic substrate (pumice, rockwool, sand) may contain a bit of organic debris (old roots). A water culture contains little organic matter and hence the roots are unprotected and are the first to come in contact with the peroxide. In contrast, in organic media the peroxide will disappear quickly and will hardly reach the roots. Therefore cleaning the irrigation system with hydrogen peroxide is more dangerous in water cultures than in a peat-based medium.

Recommendations

The recommended dose for cleaning the irrigation system is not set in concrete. One advice says to dose around 10 ppm hydrogen peroxide in the nutrient solution tank, whereas another recommends 25 ppm or more. A higher dose is meant for dirty water and/or media-based culture. However, in our experiment a daily dose of 8-12 ppm reduced the growth of hydroponic lettuce plants. Thus the grower has to find the right balance between cleaning the system and reducing growth. The grower can reduce or increase the dose depending on the results and plant damage.

The irrigation system must be flushed weekly to prevent clogging of drippers by the debris loosened by the peroxide. When a higher concentration is used the cleaning goes faster, but there is more risk of clogging the capillaries, as well as risks for plant damage.

The peroxide levels should be checked using the test strips at the first drippers nearest to the tank as well as at the last drippers. If there is no peroxide coming from the first drippers the dose can be increased. It takes weeks to months until all lines are cleaned, and the peroxide reaches the last line. Also the roots of the first plants must be monitored, to see if the plants cope with the peroxide.

Pathogen control in soilless cultures - part 9

Some general recommendations: hydrogen peroxide must be added to the mixing tank; addition to a stock solution is complicated and can give serious trouble. The nutrient solution should have a pH of 6 or lower to enable the peroxide to work. Hydrogen peroxide can possibly interfere with biological control agents or agrichemicals used for root disease control. A final note is that safety rules have to be observed when mixing, storing and working with concentrated hydrogen peroxide solutions.

Acknowledgements

With thanks to Dr. Michael Del Grosso, Degussa Peroxide Ltd., Morrinsville (ph 07-8898020) and Mr Don Slade (consultant, Palmerston North, ph. 06-3567679) for information and practical advice about hydrogen peroxide.

Table. Amounts of hydrogen peroxide solution needed to obtain the required concentrations (ppm w/v). Hydrogen peroxide solutions in various strengths (%) with the associated specific weight. Amounts needed are expressed in gram solution per m³ water and also in ml solution per m³ water.

strenght (specific weight) amount	100% (1.45 g/ml)		70 % (1.29 g/ml)		60 % (1.25 g/ml)		50% (1.19 g/ml)		35 % (1.13 g/ml)		6 % (1.02 g/ml)	
	<u>g/m³</u>	<u>ml/m³</u>	<u>g/m³</u>	<u>ml/m³</u>	<u>g/m³</u>	<u>ml/m³</u>	<u>g/m³</u>	<u>ml/m³</u>	<u>g/m³</u>	<u>ml/m³</u>	<u>g/m³</u>	<u>ml/m³</u>
0 ppm	1.0	0.7	1.4	1.1	1.7	1.3	2.0	1.7	2.9	2.5	16.7	16.3
5 ppm	5.0	3.4	7.1	5.5	8.3	6.7	10.0	8.4	14.3	12.6	83.3	81.7
10 ppm	10	7	14	11	17	13	20	17	29	25	167	163
15 ppm	15	10	21	17	25	20	30	25	43	38	250	245
20 ppm	20	14	29	22	33	27	40	34	57	51	333	327
30 ppm	30	21	43	33	50	40	60	50	86	76	500	490
40 ppm	40	28	57	44	67	53	80	67	114	101	667	654
50 ppm	50	34	71	55	83	67	100	84	143	126	833	817
60 ppm	60	41	86	66	100	80	120	101	171	152	1000	980
70 ppm	70	48	100	78	117	93	140	118	200	177	1167	1144
80 ppm	80	55	114	89	133	107	160	134	229	202	1333	1307
90 ppm	90	62	129	100	150	120	180	151	257	228	1500	1471
100 ppm	100	69	143	111	167	133	200	168	286	253	1667	1634