Horticultural discharge water purification for Environmental impact reduction

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Background

In greenhouse horticultural areas in the Netherlands plant protection products (PPPs) are measured in concentrations exceeding the environmental standards in surface waters. Intended measures:

- Generic obligation for application of purification technologies by individual growers
- Purification technologies part of legal instructions for specific PPPs

Objectives

- Testing the efficacy of PPP purification technologies common in the water treatment industry for application on greenhouse discharge water;
- Testing ecotoxicity of purified greenhouse discharge water (formation of toxic metabolites).

Methods for testing technologies

- Tests are performed with Standardised Water (Van Ruijven, 2014),
  - Representative for realistic worst-case composition of greenhouse discharge water for nutrients, organic and mineral matter
  - Addition of environmentally harmful PPPs used in greenhouses.
- Samples are chemically analysed on the presence of PPPs (LC-MS/GC-MS) and ecotoxicity (*Daphnia magna*) before and after treatment.
- The restricted maximum likelihood approach is used to calculate the purification efficacy of the technologies.

Tested technologies and applications (Figure 1):

- H_2O_2 + low pressure UV (LPUV)
- H_2O_2 + medium pressure UV (MPUV)
- Batch wise treatment O_3 + LPUV
- Inline treatment H_2O_2 + O_3 + LPUV
- Multiple treatment with H_2O_2 +LPUV (Fig. 2)

Results PPP removal

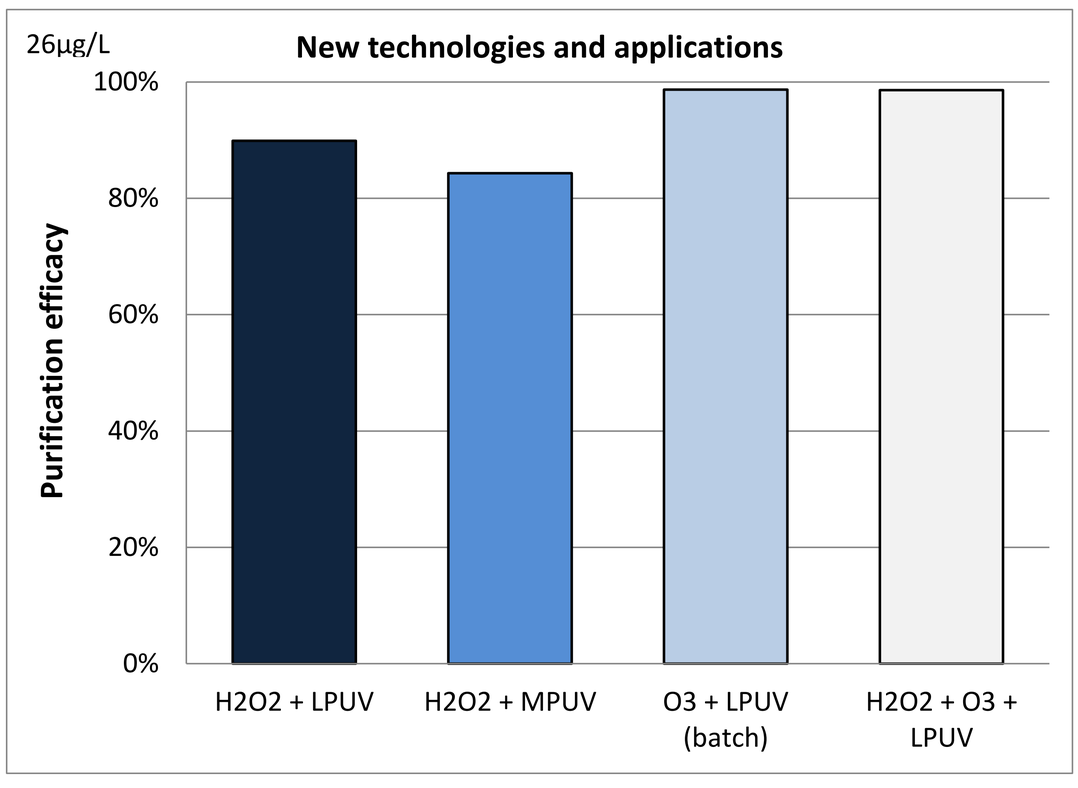

Figure 1. Standardised Water with a total concentration of 26µg/L PPPs treated batch wise with O_3 + low pressure UV and inline with H_2O_2 + O_3 + low pressure UV, compared to earlier results with inline treatment with H_2O_2 + low/medium pressure UV.

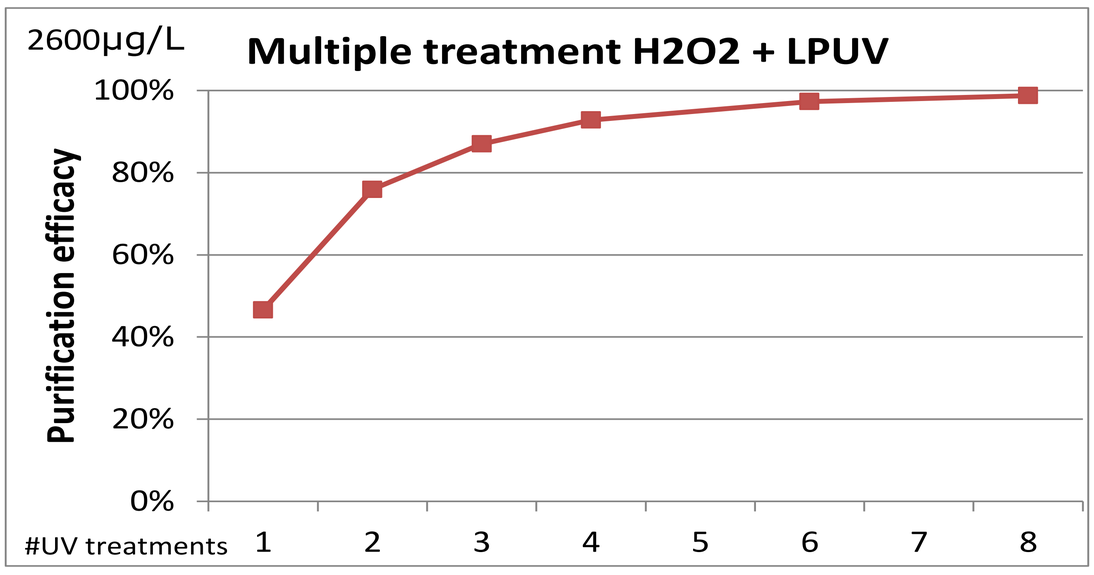

Figure 2. Treatment of Standardised Water with a total concentration of 2600µg/L PPPs with a single dose of 50mg/L H_2O_2 and multiple applications of 500mJ/cm^2 low pressure UV

Multiple treatment increases purification efficacy, but requires larger treatment capacity (Fig. 2).

Results ecotoxicity

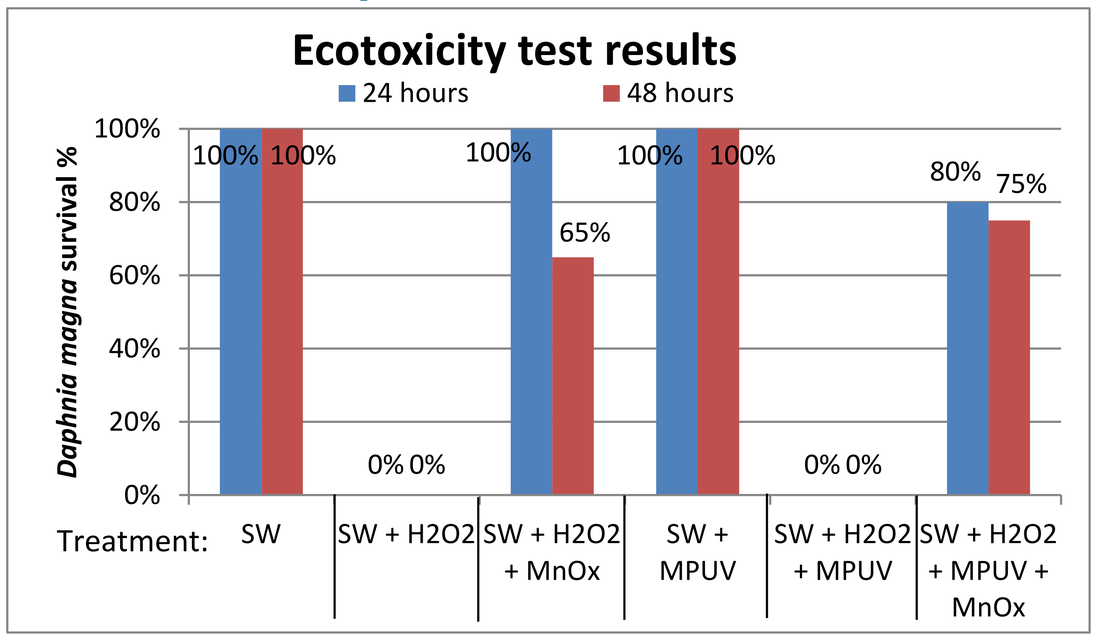

Figure 3. Ecotoxicity of Standardised Water (SW) treated with H_2O_2, middle pressure UV (MPUV) and H_2O_2 + middle pressure UV. Manganese oxide (MnOx) was used to remove the ecotoxic effect of remaining H_2O_2 (measurements executed by Ecofide).

Addition of H_2O_2 has dramatic effects on survival of Daphnia, however MnOx annuls those effects (Fig. 3). Reduced survival (compared to SW) can be attributed to ecotoxic metabolites.

Conclusions

- PPPs can be removed from greenhouse discharge water with common purification technologies;
- Application of these technologies may increase ecotoxicity probably by formation of ecotoxic breakdown products;
- Further investigations are required for appropriate purification protocol for greenhouse growers.

Reference

Van Ruijven, JPM, Van Os, EA, Van der Staaij, M, Beerling, EAM (2014). Evaluation of Technologies for Purification of Greenhouse Horticultural Discharge Water. Acta Hort. (ISHS) 1034, 133-140.

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