Water flows and emissions in Dutch greenhouses

Workshop on leakage of pesticides from greenhouses

11-12-2020; Erik van Os, Jim van Ruijven

E: erik.vanos@wur.nl; jim.vanruijven@wur.nl

WAGENINGEN UNIVERSITY & RESEARCH

1

Wageningen Research - Greenhouse Horticulture

2

Area greenhouses (in NL)

- 9000 ha in total:
  - 50% > 5 ha, which is 15% of the number of companies
  - 40% of the number of companies <1.5 ha
  - 3500 companies
- NL: 80% soilless
- Major crops in NL:
  - Tomato 1700
  - Sweet pepper 1200
  - Cucumber 550
  - Strawberry 350
  - Rose 250
  - Gerbera 160
  - Chrysanthemum (Soil) 450
  - Potted plants 2000

Werkboek Oostland, 2020

WAGENINGEN UNIVERSITY & RESEARCH

3

Type of greenhouses

- High tech fully climatized
- Venlo-type grh, 8 m span
- 1 or 2 screens (energy, shadow)
- Artificial lighting: high pressure sodium ➔ LED
- Collection of rainwater
- Use of natural gas, has to go down
- Heating: 5 x 51mm pipes per 4 m
- Additional CO2: pure or from industry
- Heat water storage for day/night use
- Heat Power Contraction, depending price gas/electricity
- Geothermal power: coming up

WAGENINGEN UNIVERSITY & RESEARCH

4

4

Westland surface water

WAGENINGEN UNIVERSITY & RESEARCH

Ditches, canals, surface water

5

5

Surface water

6

Cultivation systems





WAGENINGEN UNIVERSITY & RESEARCH

7

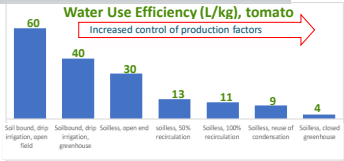
7

Water use in Dutch greenhouse production

Increased efficiency (L/m²/yr)

System	Reuse	Fresh water	Supply	Trans-piration	Fixed in crop	Drain water	Discharge
Soil	0	1680	1680	800	40	840	840
Soilless, open	0	1200	1200	800	40	360	360
Soilless, recirculation, present situation							
Soilless, recirculation, zero emission							
Soilless, closed greenhouse, gaining transpiration water							

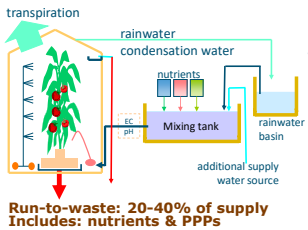
Supply = fresh water + reuse
Reuse = drain - discharge



WAGENINGEN UNIVERSITY & RESEARCH

8

Open System

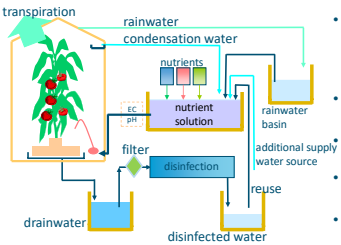


- Rainwater:
  - Good quality
  - Tanks or basins
  - <50% of water need
- Condensation water:
  - PPPs further good quality
  - 10% of water need
  - in small grh more effect of leaking to environment: more side walls
  - Side walls: not collected
- Additional water
  - Surface water
  - Quality? Diseases, nutrients, chemicals
  - Price?
- Benefits Open system:
  - No disease spread
  - No complicated fertilization
  - Cheap

WAGENINGEN UNIVERSITY & RESEARCH

9

Closed system with disinfection

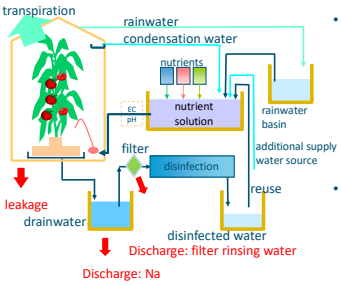


- Rainwater:
  - Good quality
  - 75-90% of water need
  - 1500 m³/ha
- Recirculation
  - Disinfection
- Condensation water collected
- Additional water
  - NL: reverse osmosis
- Costs:
  - Disinfection
  - Analysing nutrient composition required
- Benefits:
  - Saving water & fertilizers
  - No environmental pollution

WAGENINGEN UNIVERSITY & RESEARCH

10

Closed system with leakage and discharge

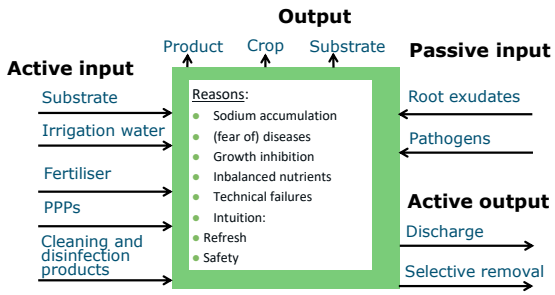


- Leakage inside grh:
  - Connections pipework
  - Drippers drip wrong
  - Overflow troughs
  - Overflow basins
  - First drain after puncturing slabs
  - PPPs
  - About: 1.5%
- Discharge sodium
  - [Na] above threshold level → toxic
  - Composition unbalanced
  - PPPs
  - About: 0-10%;
- Filter rinsing water
  - Nutrients and PPPs
  - About: 2-4%

WAGENINGEN UNIVERSITY & RESEARCH

11

Water quality issues

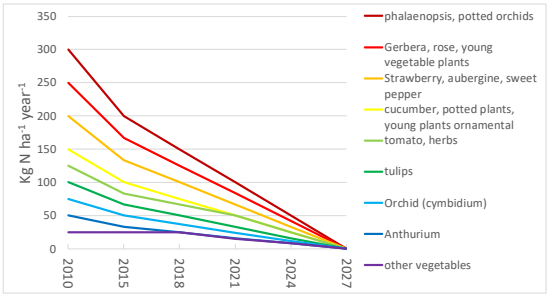


WAGENINGEN UNIVERSITY & RESEARCH

12

12

Nitrogen emission standards

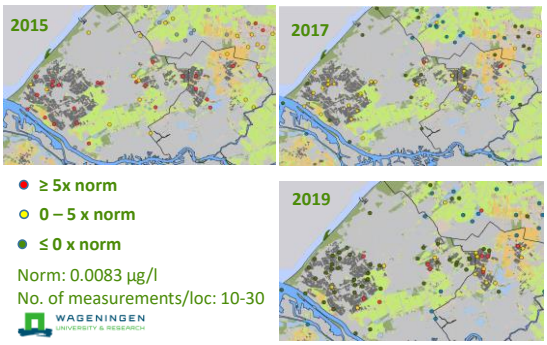


WAGENINGEN UNIVERSITY & RESEARCH

13

13

Imidacloprid in surface water: less exceedances



- ≥ 5x norm
- 0 – 5 x norm
- ≤ 0 x norm

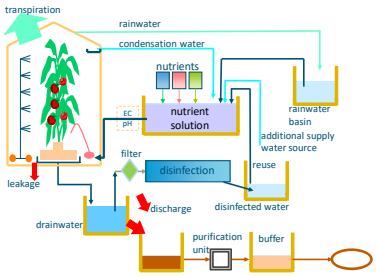
Norm: 0.0083 µg/l

No. of measurements/loc: 10-30

WAGENINGEN UNIVERSITY & RESEARCH

14

Purification of discharge



- Sewer system (if available)
- Surface water

WAGENINGEN UNIVERSITY & RESEARCH

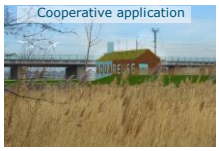
15

15

Obligatory removal of PPPs

- Approved technology on official list
- 95% efficacy in removal
- Treatment registration
- No financial compensation


Individual application


Cooperative application


Mobile application


Zero Liquid Discharge

WAGENINGEN UNIVERSITY & RESEARCH

16

16

Growers towards zero liquid emission

- Rainwater collection
- Collection of condensation water (obligatory)
- Recirculation of drain water (obligatory)
- Draining of slabs in 2 stages to avoid overflow of troughs
- Start recirculation from planting onwards
- End of cultivation strategy: emptying slabs/tanks and reducing [N], [P] in slabs
- Emission standards for nitrogen in discharge water
- Approaching zero emission in 2027
  - Funding for research to achieve this goal

WAGENINGEN UNIVERSITY & RESEARCH

17

17

Cleaning after cultivation

- End of cultivation strategy
  - Emptying slabs / storage tanks
- PPP filling station
- Cleaning:
  - Plant material: centralized composting
  - No run-off from premises:
    - paved area forbidden
    - containers for storage: leak free
  - Troughs
  - Greenhouse
  - Irrigation lines

WAGENINGEN UNIVERSITY & RESEARCH

18

18

Finishing the crop

WAGENINGEN UNIVERSITY & RESEARCH

19

Conclusions

- Need for clean surface water (EU Water Framework Directive)
- Obligatory recirculation of drain water
- Obligatory collection and use of condensation water
- Discharge mostly on sewer system
  - Nitrogen emission standards
  - Purification of discharge water for removal of PPPs
- Leakage (1.5%) is difficult to collect, as it is diffuse

➔ Closed water systems towards zero emission

WAGENINGEN UNIVERSITY & RESEARCH

20

References

- Leyh, R., Van Os, E. A., Blok, C., Van Ruijven, J. P. M., & Kaarsemaker, R. (2020). Strategy to minimise nitrogen load to finish a zero discharge cultivation. *Acta Horticulturae*, *1273*, 137-144. https://doi.org/10.17660/ActaHortic.2020.1273.19
- van der Linden, A. M. A., Hoogsteen, M. J. J., Boesten, J. J. T. I., van Os, E. A., & Wipfler, E. L. (2017). *Fate of plant protection products in soilless cultivations after drip irrigation: measured vs. modelled concentrations: Interpretation of the 2014 experiment with the Substance Emission Model*. (RIVM report; No. 2016-0063). National Institute for Public Health and the Environment. https://edepot.wur.nl/421122
- van der Salm, C., Voogt, W., Beerling, E., van Ruijven, J., & van Os, E. (2020). Minimising emissions to water bodies from NW European greenhouses; with focus on Dutch vegetable cultivation. *Agricultural Water Management*, *242*, [106398]. https://doi.org/10.1016/j.agwat.2020.106398
- Van Os, E. A., Beerling, E. A. M., Blok, C., Leyh, R., Van Ruijven, J. P. M., Van Der Staaij, M., Janse, J., Kaarsemaker, R., & Roosen, W. (2020). Zero liquid discharge in soilless greenhouse horticulture: Solutions to save water and the environment while ensuring an optimal production. *Acta Horticulturae*, *1273*, 129-135. https://doi.org/10.17660/ActaHortic.2020.1273.18
- van Ruijven, J., van Os, E., Beerling, E., Blok, C., & Janse, J. (2019). Towards zero-liquid discharge in hydroponic cultivation. *Acta Horticulturae*, *1242*, 863-871. https://doi.org/10.17660/ActaHortic.2019.1242.127
- Van Ruijven, J. P. M., Van Os, E. A., Van Der Staaij, M., Eveleens-Clark, B., & Beerling, E. A. M. (2020). Implementation of purification equipment for removal of plant protection products from horticultural discharge water. *Acta Horticulturae*, *1273*, 145-152. https://doi.org/10.17660/ActaHortic.2020.1273.20
- Wipfler, E. L., Beltman, W. H. J., Boesten, J. J. T. I., Hoogsteen, M. J. J., van der Linden, A. M. A., va Os, E. A., van der Staaij, M., & Swinkels, G. L. A. M. (2020). *Testing of the Greenhouse Emission Model for application of plant protection products via drip irrigation in soilless cultivation*. (Report / Wageningen Environmental Research; No. 3004). Wageningen Environmental Research. https://doi.org/10.18174/522831

WAGENINGEN UNIVERSITY & RESEARCH

21

Thank you for your attention!

Any questions?

More information:
- erik.vanos@wur.nl
- Jim.vanruijven@wur.nl

WAGENINGEN UNIVERSITY & RESEARCH

22