A pragmatic approach to derive greenhouse scenarios for emissions to groundwater and surface water for soil-bound cultivation in Southern Europe

Combining EFSA (2014) protected crop guidance with FOCUS open-field approaches

INTRO

- Operational exposure scenarios for emissions from low-tech southern European greenhouses are missing
- This leads to the situation that in practice greenhouse uses are assessed almost like field uses (excluding run-off) which ignores the specific conditions in a greenhouse which systematically reduce emissions
- EFSA[1] guidance describes layout elements but no complete scenario(s)
- Such scenarios were developed for the receptors groundwater and surface water for soil-bound cultivation

Summary

- Generic greenhouse scenarios were defined
  - adopting the Italian leaching scenario example from the EFSA[1] guidance on protected crops
  - complementing this scenario with daily climate data and established method to schedule irrigation
  - adding a surface water drain flow scenario
- Conceptual foundation adopted from FOCUS open-field approach
  - drivers for leaching/generation of drain flow are climate and soil
  - irrigation is worst case compared to peer reviewed literature and EFSA[1] guidance
  - worst case FOCUS open-field soil conditions
- Approach is heuristic and pragmatic
- Reduction of PEC as compared to open-field are plausible and can be explained by reduced net water flow (percolation and drain flow)

Scenario Derivation and Design

EFSA[1] guidance

"Example leaching scenario concerning a covered soil-bound tomato crop in Italy"

- FOCUSgw Piacenza soil
- monthly greenhouse climate (Apr-Sep)
- daily open-field weather (Pistoia, Italy)
- tomato crop calendar
- generic over-irrigation factor f_{over} (20 % above crop water demand)

FOCUS open-field approach

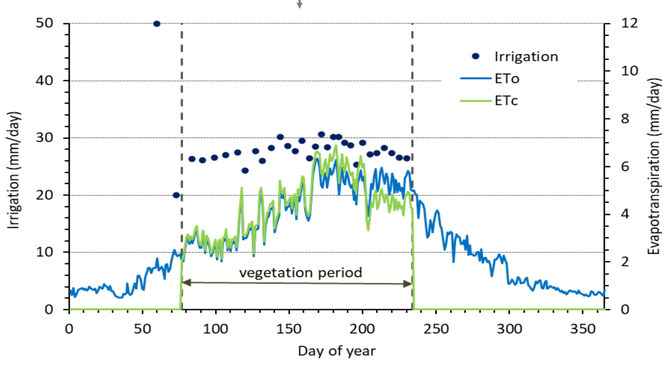
Benchmark scenarios representing realistic worst case (vulnerable) environmental conditions for leaching[A] and generation of drain flow[B] driven by

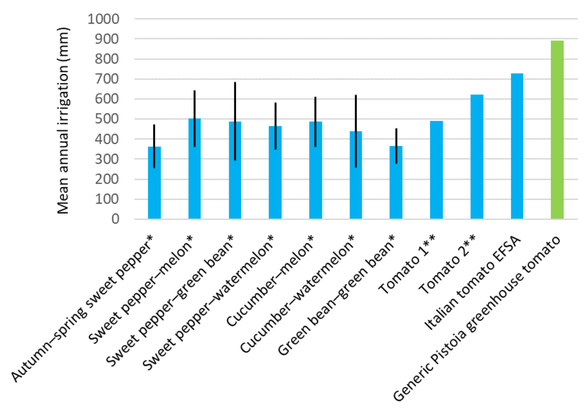
- net water flow (rain – evapotranspiration)[A,B]
- temperature (T)[A,B]
- organic carbon[A,B]
- permeability, preferential flow paths[B]

→ Drivers of leaching and drain flow emissions from a low-tech greenhouse with soil-bound cultivation are the same than for open field

Construction of generic daily greenhouse climate for Pistoia (Italy)

- daily ΔT data inside – outside greenhouse[2] to construct daily T inside the greenhouse for Pistoia data set from the guidance, transmissivity[2]
- determination of crop water demand (ET_c) with Hargreaves equation (ET_0)[3] and crop calendar from guidance[1] incl. crop coefficients (K_c)
- irrigation = $ET_c \cdot (1 + f_{over})$ → net water flow ≈ $ET_c \cdot f_{over}$
- irrigation exceeding values in the guidance[1] and literature[4,5]

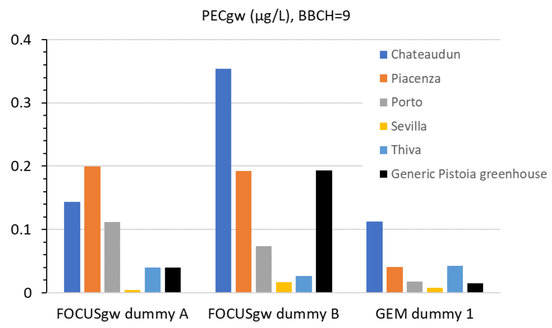




Generic Pistoia leaching scenario

- generic greenhouse climate and tomato crop calendar
- FOCUSgw Piacenza soil parameters
- implementation: FOCUS PEARL
- PECgw compared to max. of FOCUS open-field by factor 2 - 900 lower (3 compounds x 5 BBCH tested)

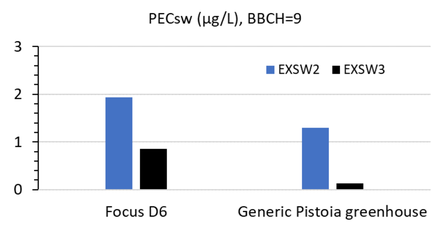
Example for early application which delivers maximum PECgw



Generic Pistoia surface water scenario

- generic greenhouse climate and tomato crop calendar
- FOCUSsw D6 (Thiva) soil parameters and water body (ditch)
- implementation: FOCUS MACRO and TOXSWA
- PECsw compared to FOCUS D6 open-field by factor 1.2 - 24 lower (2 compounds x 5 BBCH tested)

Example for early application which delivers maximum PECsw



REFERENCES

[1]EFSA (2014). Guidance Document on clustering and ranking of emissions of active substances of plant protection products and transformation products of these active substances from protected crops (greenhouses and crops grown under cover) to relevant environmental compartments. EFSA Journal 2014;12(3):3615, 43 pp., doi:10.2903/j.efsa.2014.3615. Accessed 24 June 2022, https://www.efsa.europa.eu/de/efsajournal/pub/3615

[2]Fernández, M. D., López, J. C., Baeza, E., Céspedes, A., Meca, D. E. and Bailey, B. 2014: Generation and evaluation of typical meteorological year datasets for greenhouse and external conditions on the Mediterranean coast. Int J Biometeorol, doi: 10.1007/s00484-014-0920-7

[3]Fernández, M.D., Bonachela, S., Orgaz, F., Thompson, R., López, J.C., Granados, M.R., Gallardo, M. andFereres, E. 2010. Measurement and estimation of plastic greenhouse reference evapotranspiration in a Mediterranean climate. Irrig Sci 28:497-509, doi: 10.1007/s00271-010-0210-z

[4]Fernández, M.D., González, A.M., Carreno, J., Pérez, C. amd Bonachela, S. 2007. Analysis of on-farm irrigation performance in Mediterranean greenhouses. Agricultural Water Management 89, 251–260

[5]Martínez-Blanco, J., Muñoz, P., Antón, A., and J. Rieradevall. 2011. Assessment of tomato Mediterranean production in open-field and standard multi-tunnel greenhouse, with compost or mineral fertilizers, from an agricultural and environmental standpoint, Journal of Cleaner Production, Volume 19, Issues 9–10

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