Risk Assessment for Protected Crops – Approaches Towards Harmonized Leaching Scenarios

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Introduction and Objective

Groundwater assessment in protected crops is driven by several factors, such as temperature, evapotranspiration, and irrigation. Irrigation scheduling plays an important role in greenhouse cultivation, since under-irrigation results in yield losses, and over-irrigation triggers susceptibility of the crop to diseases and provokes nutrient loss (Pardossi and Incrocci, 2011). The recently published EFSA guidance on protected crops (EFSA, 2014) provides recommendations on exposure assessment in protected crops in the regulatory context. However, only an illustrative, non-representative example scenario is provided for ground water exposure assessment in walk-in tunnels and greenhouses. Applicants are required to develop suitable scenarios. We present a scenario for standard Southern European walk-in tunnels and low-tech greenhouses in line with EFSA guidance on protected crops and with a coherent consideration of the driving factors, such as irrigation and evapotranspiration.

Materials and Methods

- **Crop:** tomato (season: 16th Aug – 30th May); crop definition adapted from EFSA (2014)
- **Soil:** original FOCUS Southern European soils (Sevilla, Piacenza, Porto, Thiva)
- **Temperature and radiation:** Sevilla scenario, because it best represents Southern European Greenhouse conditions, compared with a Typical Meteorological Year Dataset for Mediterranean greenhouses (Fernandez et al., 2014)
- **Evapotranspiration (ET_{ref}):** estimated, using the Hargreaves equation (as proposed in Fernandez et al., 2010), assuming a greenhouse transmissivity of 65% (Fernandez et al., 2014)
- **Irrigation:** based on the actual plant demand, calculated as ET_{ref} * crop K_c (Pardossi and Incrocci, 2011), + 20% over-irrigation to avoid salinization (EFSA, 2014). In addition, events for soil disinfection and rewetting after the fallow period were included (Gallardo, 2013)

Table 1: Mean annual irrigation amounts in Southern European greenhouses

	Irrigation during cropping [mm]	Irrigation during fallow period [mm]
Presented scenario (Sevilla soil)	388	70
Reported amounts	363 – 502*	70**

* Fernández et al., 2007: mean annual irrigation in typical crops in the Almería region
** Gallardo et al., 2013

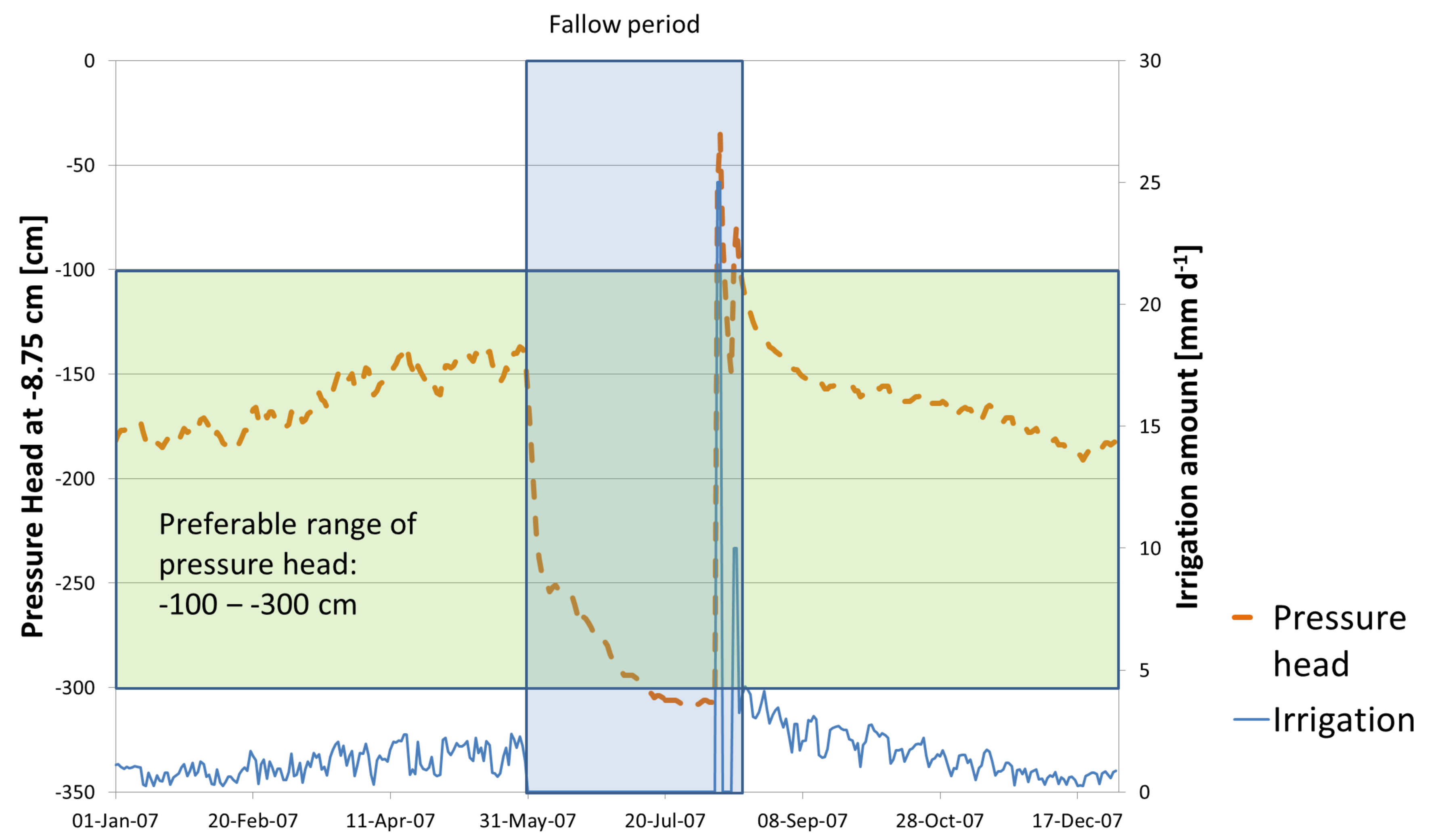

Figure 1: Dynamics of pressure head and daily irrigation amounts for greenhouse tomatoes in FOCUS Sevilla soil - 7th year of standard 26 years FOCUS assessment (FOCUS PEARL 4.4.4).

Benefits of the proposed strategy

- ✓ Scientifically sound and easy-to-construct scenarios for leaching assessment of Southern European greenhouses and walk-in tunnels according to EFSA protected crops guidance (EFSA, 2014)
- ✓ Typical Mediterranean greenhouse conditions regarding climate, irrigation, and cropping
- ✓ Irrigation regime and amount tailored to plant requirements, including over-irrigation to avoid salinization
- ✓ Irrigation regime validated by comparison with literature, recommended pressure heads, and cultivation practices
- ✓ Adequate in terms of preferable range of pressure head
- ✓ Easily adoptable to new cropping/temperature/soil combinations

Table 2: Mean annual recharge in 1 m depth

Scenario	%-tage recharge
Presented (Sevilla greenhouse)	18
EFSA example scenario	15
FOCUS Sevilla (field)	12

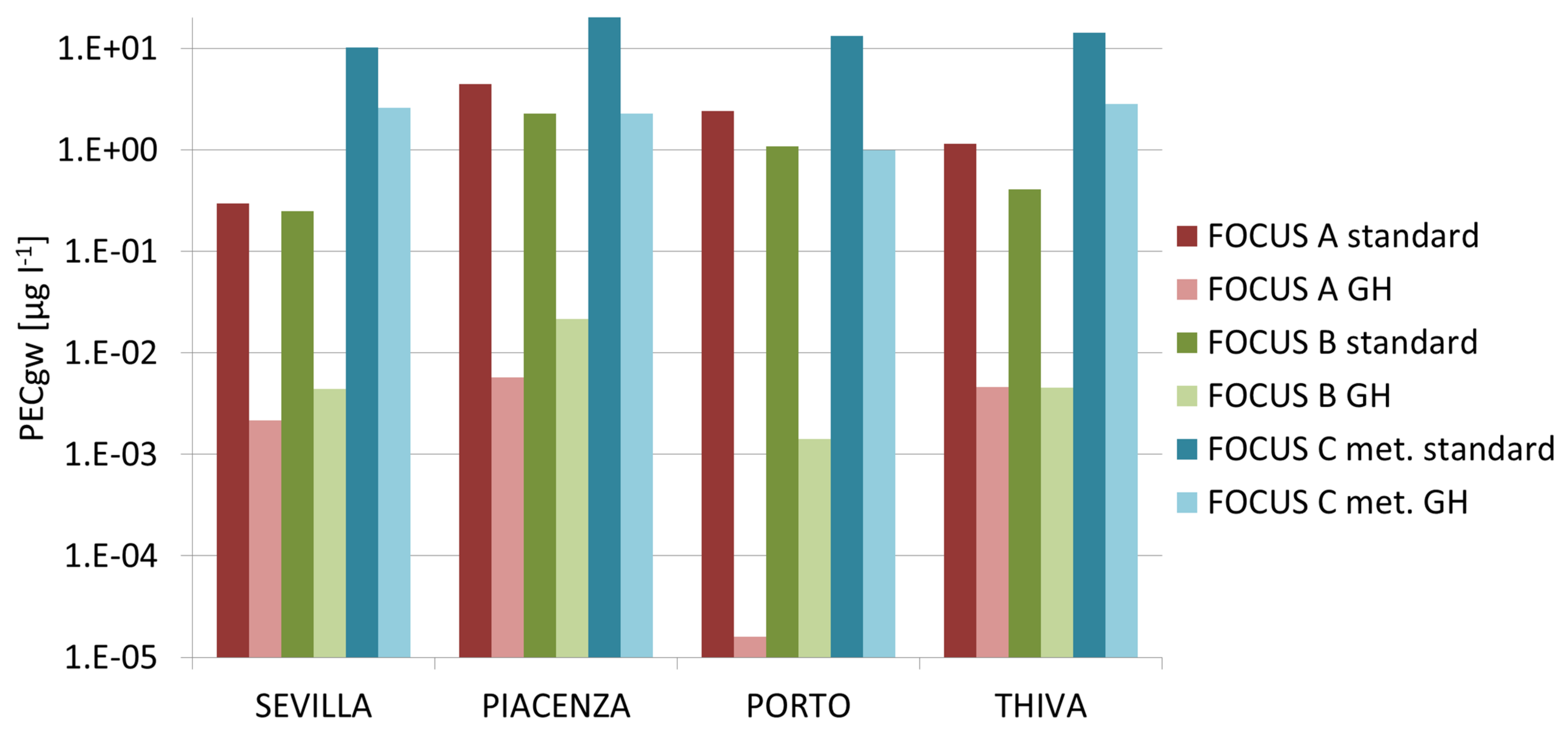

Figure 2: PECgw resulting from simulations using the proposed greenhouse assessment or standard FOCUS modeling procedure (1 x 1 kg ha^{-1}), respectively.

Results & Discussions

The proposed scenario was validated by assessing three criteria (shown here for Sevilla soil):

- The total irrigation amounts should be comparable to irrigation reported in the literature.
  - ✓ The total irrigation amount is within the range of typical Mediterranean greenhouses (Table 1).
- The pressure head should be in the range of -100 to -300 cm to ensure favorable growth conditions (Fundacion Cajamar, 2005).
  - ✓ During the whole cropping period, the proposed irrigation regime ensured a pressure head within the optimum range (Figure 1).
- A fraction of about 10 - 20% of irrigation should percolate to 1 m depth, to avoid salinization while maintaining water use efficiency.
  - ✓ The recharge fraction is within this range, and slightly higher than in the FOCUS field approach and in the EFSA example scenario (Table 2).

Analogous results were obtained for the other Southern European greenhouse scenarios (not shown).
Figure 2 shows corresponding PECgw after application of the 3 standard FOCUS substances A - C of 1 x 1 kg ha^{-1} one week after transplanting in both the regular FOCUS period and the season proposed herein. Our greenhouse assessment leads to lower PECgw in all cases under investigation.

Conclusions

The proposed methodology for evapotranspiration and irrigation produces a scenario that matches the criteria as laid down in the ESFA guidance and meets the validation criteria defined above (%-tage recharge; optimal wetting conditions; total irrigation amount). The developed scenario provides a suitable basis for leaching assessment in Southern European greenhouses and walk-in tunnels.

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