Emissions of plant protection products from protected crops to environmental receptors

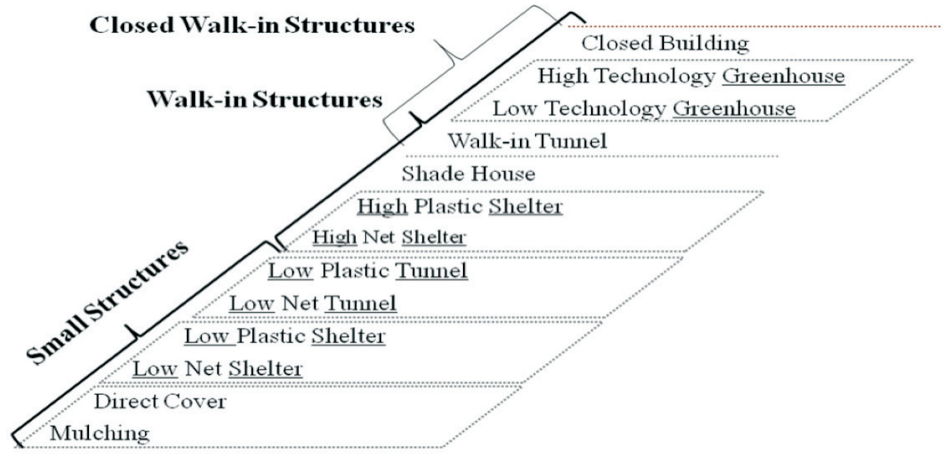
VAN DER LINDEN A.M.A.[1], BARCELO D.[2], CAPRI E.[3], CORNELESE A.A.[4], EGSMOSE M.[5], ÖSTGREN J.[6], PARDOSSI A.[7], STANGHELLINI C.[8], STEURBAUT W.[9]

1 - RIVM, Bilthoven, the Netherlands, 2 - IDAEA, Barcelona, Spain,
3 - Università Cattolica del Sacro Cuore, Piacenza, Italy, 4 - Ctgb, Wageningen, the Netherlands,
5 - EFSA, Parma, Italy, 6 - KEMI, Sundbyberg, Sweden, 7 - University of Pisa, Pisa, Italy, 8 - Wageningen UR, Greenhouse Horticulture, Wageningen, the Netherlands, 9 - Ghent University, Gent, Belgium
Email Ton.van.der.Linden@rivm.nl

Authorisation of plant protection products (PPPs) in the European Union distinguishes between applications of these substance to crops in open field and crops grown under cover. However, risk assessment for applications to covered crops lags well behind that for open field. In several areas, occurrences of PPP in surface water were attributed to their use in protected crops and therefore EFSA and several EU member states initiated research to enable risk assessment in the near future.

Crop production under cover is becoming more and more important in the EU. The variability in cover structures is quite large and ranges from rather open plastic shelters to fully climate controlled greenhouses (Figure 1). All these structures however cannot be considered fully closed and emissions may occur (EFSA, 2010). Crop growth requires the structures to be ventilated and some excess water has to be supplied to avoid salinisation of the growing system (both soil bound and soilless cultivation). Ventilation and leaching or discharge were identified as potentially the major driving forces of emissions of PPP from protected crops.

Figure 1 - Main categories of protection structures. Small structures are not accessible to the workers, and are generally temporary. Walk-in structures are large enough to work in the structure and may be closed at all sides with water-proof screens



Dependent on the receptor and the major driving forces, a series of models are necessary to calculate:

1. climatic conditions in the structure, taking into account outside climatic conditions, with for example the ventilation rate of the structure as a result;
2. crop water requirements;
3. a model for distributing water to the crop, based on available water sources and the quality of the water;
4. depending on the growing system, a model for calculating water discharge from soilless systems or drainage / leaching from soil-bound systems;
5. models for calculating emissions of plant protection products and resulting concentrations in the receptors air, groundwater, soil and surface water.

For example, Vermeulen et al. (2010) and Beulke et al. (2011) coupled several models to calculate emissions to air, groundwater and surface water. In example calculations, they confirmed ventilation and leaching respectively discharge as the major driving forces for emissions and showed that emissions are indeed possible. For selected cultivations in walk-in tunnels and greenhouses, calculated emissions to air were of the same order of magnitude as in comparable open field cultivations. Leaching to groundwater and drainage to surface water from greenhouses were calculated to be lower than in comparable open field cultivations for temperate climatic conditions (Beulke et al., 2011). Temperature differences were identified to be the major factor in the lower leaching.

Recirculation of water in soilless system may diminish or prevent emissions via discharge. In case of insufficient water of high quality, however, discharge of too saline recirculating water is necessary and any PPP contained in it will be emitted, usually to surface water. Such emissions may be substantially higher than emissions from open field (Vermeulen et al., 2010, Beulke et al., 2011). Also condensation may contain PPP and thus be a source of emission. Discharge from recirculating nutrient solution and condensation have no equivalent emission routes in open field cultivations.

Based on the example calculations and considering the major driving forces, cultivations in closed walk-in structures were identified as cultivations for which risk assessment methodology, including scenarios, needs to be developed (see Table 1). Existing risk assessment methodology for open field does not cover major emission routes (discharge and condensation) or may overestimate emissions from closed walk-in structures because scenarios are not representative of protected crop cultivation. Emissions from other walk-in structures and small structures are expected to be not significantly different from open field systems.

Table 1 - Covered cropping systems which were identified having high priority for establishment of risk assessment methodology

construction	system	application	emission	receptor
greenhouse	soil no recirculation	spray	leaching/drainage	groundwater
			drift	surface water
			condensation	
			gas phase emission at application	
walk-in tunnel	soil no recirculation	spray	gas phase emission at application	groundwater
			leaching/drainage	surface water
greenhouse	soilless with recirculation	drip irrigation spray	discharge	surface water
greenhouse	soilless without recirculation	drip irrigation spray	discharge condensation	surface water

KEY WORDS: Pesticides, greenhouse, risk assessment, air, groundwater, surface water

Acknowledgements

This work is carried out by the EFSA Panel on Plant Protection Products and their Residues (PPR), working group on new guidance development on emissions from protected crops.

References

Beulke S., van Beinum W. , Glass R., van Os E., Holterman H.J., Sapounas A., Voogt W., van de Zande J., de Zwart F., Garratt J. (2011). Estimation / calculation of emissions of Plant Protection Products from protected crops (greenhouses and cultivations grown under cover) to support the development of risk assessment methodology under Regulation (EC) N° 1107/2009 and Council Directive 91/414/EEC. http://www.efsa.europa.eu/en/supporting/pub/151e.htm

EFSA. (2010). Panel on Plant Protection Products and their Residues (PPR). Scientific Opinion on emissions of plant protection products from greenhouses and crops grown under cover: outline for a new guidance. EFSA Journal 2010; 8(4):1567. [44 pp]. doi:10.2903/j.efsa.2010.1567

Vermeulen T., van der Linden A.M.A., van Os E.A. (eds). (2010). Emissions of plant protection products from glasshouses to surface water in The Netherlands. WUR Greenhouse Horticulture report GTB-1002, RIVM report 607407001.