Emissions of plant protection products to surface water via drainage from soil-bound cultivation of protected crops

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EFSA recently commissioned a project to obtain scientific information supporting the development of EU guidance on emissions of plant protection products (PPPs) from protected crops (Beulke et al., 2011). The results are presented in several contributions in this issue. This part of the study compared model calculations of emissions to surface waters via drainage from covered crops with those from the field. Soil-bound cultivation of lettuce and chrysanthemum with irrigation according to common practice in a greenhouse in the Netherlands was considered. Application of PPP with K_{om} values of 10, 20, 35, 60, 116 or 200 L/kg and DT50 values of 10, 20, 60, 100, 150 or 200 days was made on 30 April, 10 June or 1 August at 1 kg/ha in each of 15 years. The indoor climate and water balance were simulated with KASPRO (de Zwart, 1996) and WATERSTROMEN (Voogt and van Os, 2011). A new version of PEARL (Tiktak et al., 2011) was used to simulate PPP movement through a macroporous soil into drains at 90 cm depth. Simulations were also undertaken for a generic crop in the field. The average mass lost in drainflow over the 15-year period for lettuce is compared with the field situation in Figure 1. The ratios of the losses via drainage for lettuce over those for the field are plotted against the tested DT50 values and K_{om} values in Figure 2.

Figure 1 - Simulated average annual mass in drainflow for a lettuce greenhouse crop plotted against that for the field situation. Each symbol represents one of the 108 combinations of DT50 values, K_{om} values and application dates. The dotted line indicates exact agreement between greenhouse and field

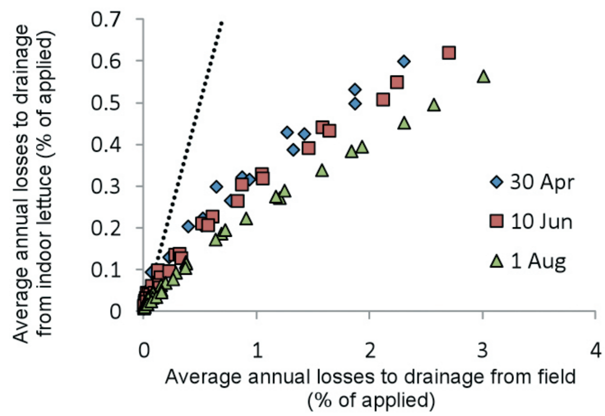
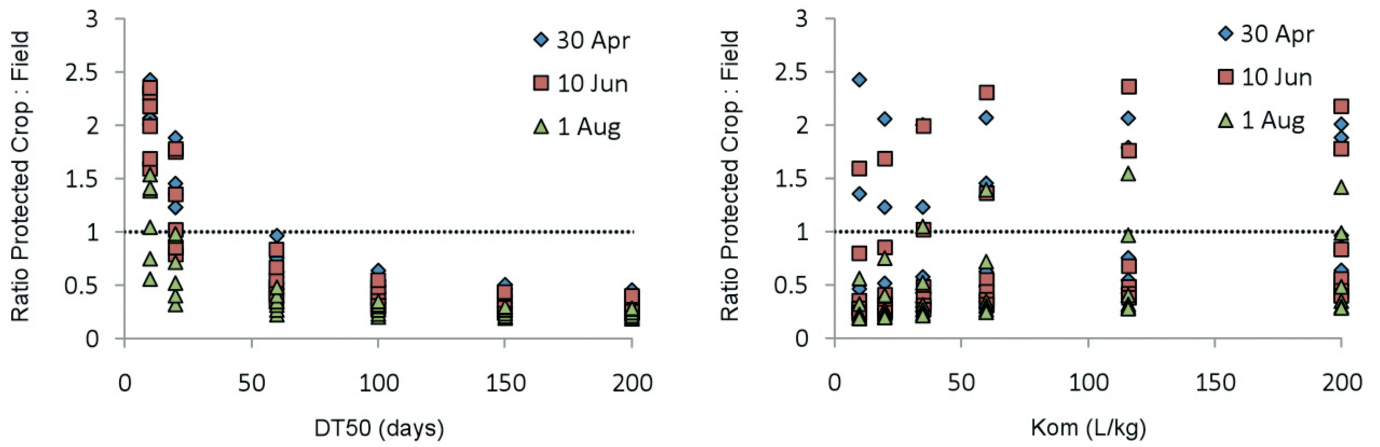


Figure 2 - Ratios of simulated average annual losses for lettuce:field, plotted against the DT50 values (left) and Kom values (right) tested in the simulations. Ratios > 1 indicate larger losses for the lettuce greenhouse crop

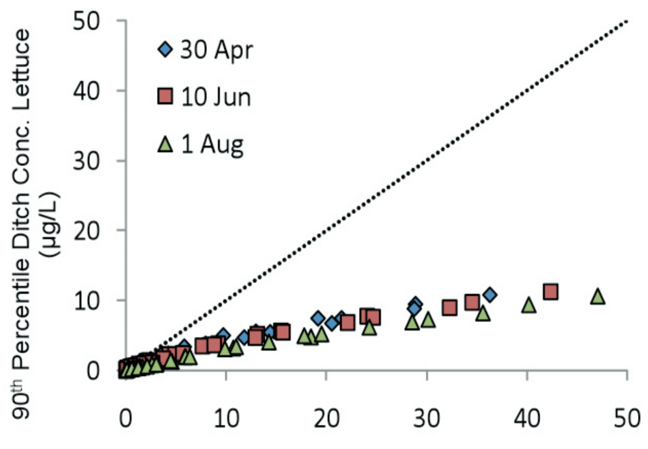


Greenhouse cultivation of lettuce led to larger losses than the field situation in 24% of the 108 cases. Losses from the lettuce crop were up to 2.5 times larger than those for the field crop. There is no consistent effect of the K_{om} values (Figure 2). Ratios smaller than 1 were observed for compounds with longer half-lives. The temperature in the greenhouse is higher than in the field and this enhances degradation. It is likely that the effect of temperature on the total annual emission is dominant for compounds with longer half-lives. For these substances, smaller losses in drainflow are simulated for lettuce than in the field.

For compounds with shorter DT50 values, the total annual mass lost depends on the movement to drains soon after application. These losses are mainly affected by the volume, intensity and timing of irrigation relative to application. The differences between the irrigation patterns for lettuce in the greenhouse and rainfall in the field can lead to larger losses in the greenhouse. But in these cases, the calculated losses were relatively small (<0.1% of applied, Figure 1).

Concentrations in a simple ditch adjacent to the treated field following discharge of drainflow into the ditch were also calculated in PEARL. The 90th percentile of the 15 annual maximum concentrations in the ditch is plotted in Figure 3 for the 108 combinations of PPP properties and application dates. The simulated 90th percentile annual maximum concentrations are larger for the greenhouse crop than the field crop for 15% of the cases; these are again associated with short half-lives. The 90th percentile concentrations are <0.5 µg/L for all of these instances.

Figure 3 - 90th percentile annual maximum ditch concentrations for lettuce plotted against those for the field situation



The study showed that emissions to surface water via drainage from soil-bound covered crops can be significant. For most compounds tested, losses from the greenhouse and concentrations in the ditch were smaller than those for the field. But, a number of uncertainties and simplifications are inherent in the simulations and the ranking of the emissions for the tested conditions relative to the whole population of relevant situations was not investigated. It may thus be necessary to develop specific scenarios to assess the potential for emissions to surface waters via drainage from protected crops. This could be considered as a higher tier option if a compound fails the regulatory risk assessment based on field scenarios.

KEY WORDS: Pesticides, protected crops, greenhouse, risk assessment, drainage, surface water

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