Countrywide risk assessment concerning the exposure of watercourses to spray drift in fruit growing in the Netherlands

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1. Introduction

For aquatic organisms, the risk of exposure to pesticides depends highly on deposits of spray drift onto surface waters. Downwind off-target deposits of spray drift have been investigated for many years. In pome fruit orchards, pesticide sprays are applied in an upward or sideways direction. As a result, downwind deposits of spray drift are significantly higher than those for field crops, for which sprays are applied in downward direction. For field crops various spray drift models have been described in literature. However, for fruit crops no models are available to assess the deposits of spray drift onto surface waters. Recently, a generic spray drift model for pesticide applications in pome fruit crops has been developed based on a large set of experimental data [1]. The model is implemented in an exposure assessment model to estimate pesticide concentrations in all edge-of-field watercourses next to pome fruit orchards in the Netherlands. This offers the possibility for realistic simulation studies on the fate of pesticides in surface waters to quantify exposure risk levels for aquatic organisms. This serves higher-tier assessment studies for the authorization of plant protection products in fruit growing.

2. Materials and methods

2.1. A generic spray drift model

After 20 years of field experiments, a considerable amount of experimental data on spray drift in fruit crops is available. Using a common cross-flow application technique, a total of 158 experiments were carried out between 1992 and 2011, resulting in more than 5400 spray deposition values on the ground downwind from a treated orchard [2]. These data form the basis of the generic model for spray drift in pome fruit orchards. Regression analysis yielded the relevant input parameters describing downwind deposits of spray drift. A multi-parameter empirical model was fitted to these data, accounting for both crop related parameters and local meteorological conditions. A special feature of the model is the seamless dependence on growth stage (through BBCH code). The model fits experimental data relatively well: the correlation coefficient is 85%. Figure 1 shows all deposition data as a function of downwind distance. The typical decay with distance is represented by a 'slackened exponential' curve [1]. The large scatter of data reflects the wide variation in experimental conditions, mainly meteorological condtions and growth stages of the trees.

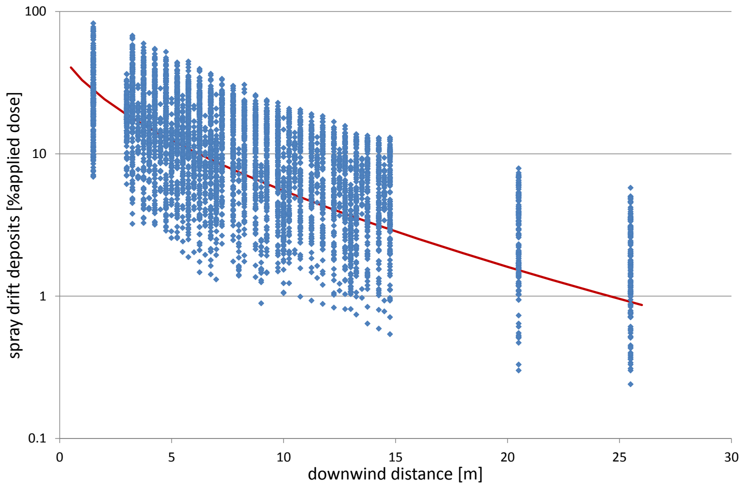

Figure 1: Downwind deposits of spray drift as a function of distance, gathered for all experiments. Solid line: typical decay as a function of distance.

2.2. Countrywide risk assessment model

For a countrywide risk assessment, the whole of the Netherlands was divided in 14 regions, each of which was characterized by specific frequency distributions for meteorology, orchards and watercourses. The spray drift model was applied to each possible spatial configuration to compute the downwind deposits under a wide variation of temporal conditions. Several spray application scenarios were tested: 1 or 3 applications in spring or in autumn, and 15 applications throughout the growing season, for both slowly and fastly dissipating pesticides. The resulting 90th percentile PEC value depends on the type of scenario. Figure 2 shows an example of cumulative probabilities for 1, 3 or 15 spray applications, for fastly dissipating pesticides. Clearly, the 90th percentile PECs may vary considerably.

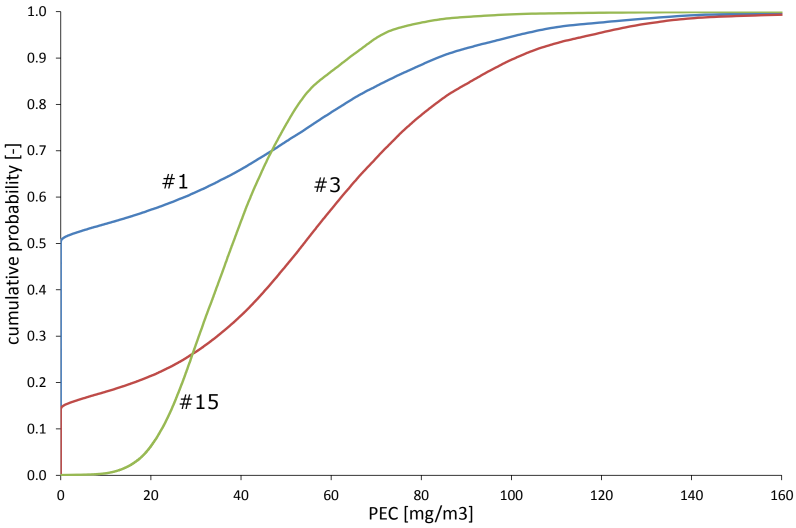

Figure 2: Countrywide cumulative probabilities and PEC for three spray application schemes: 1 and 3 applications in spring and 15 applications throughout the growing season.

3. Results and discussion

From the simulation results a spatial configuration was selected to reflect a 90th percentile risk level in each scenario. The selected spatial configuration serves as a monitoring situation in subsequent simulation studies, provided that the proper temporal percentiles are used. These temporal percentiles have been computed for various drift mitigation techniques and crop-free buffer zones. With these results, the spray drift model can be combined with the fate model TOXSWA to carry out realistic risk assessment studies on a countrywide scale.

4. Conclusions

A generic spray drift model for fruit orchards has been developed. It is implemented in a countrywide model for risk assessment studies concerning the fate of pesticides in surface waters. The latter model takes into account realistic weather conditions, varying growth stages during the growing season and regional differences in topography and meteorological conditions. Drift mitigation techniques and crop-free buffer zones are implemented as well. All of these features result in an exposure assessment model with a high level of realism. Currently, the present model is combined with the TOXSWA model describing the fate of pesticides in edge-of-field watercourses. In this way, a realistic simulation study on the fate of pesticides in surface waters can be performed to quantify exposure risk levels for aquatic organisms. This serves higher-tier assessment studies for the authorization of plant protection products.

5. References

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