VARIABILITY AND UNCERTAINTY IN ARTHROPOD EXPOSURE TO PESTICIDE DRIFT IN CROP AND OFF-CROP AREAS

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Current risk assessment procedures for non target arthropods (NTAs) in both crop and off-crop areas (ESCORT 2) are deterministic and do not consider variability (inherent in such systems) or uncertainty (due to incomplete knowledge) of either toxicity or exposure. A PSD (Defra) funded project, WEBFRAM, seeks to address and characterise variability and uncertainty of exposure and effects in order to add realism to risk assessment procedures for all non-target organisms (birds, mammals, aquatic organisms and soil dwelling invertebrates). WEBFRAM module 4 is aimed at above-ground arthropods and presented here are approaches to adding realism to exposure estimates through the characterisation of application techniques, drift profiles, crop architecture and off-field vegetation. Visit www.webfram.com for current project status.

Introduction

• ESCORT 2 provides a deterministic approach to risk assessment for non-target arthropods (NTA's) for in-field and off-field areas. Sentinel species exposed to fresh residues on glass plates represent all arthropods in both compartments at initial tiers.

• Refinement of toxicity is achieved through the conduct of effects studies on natural substrates, with aged residues, in semi- or full-field designs, with mitigation options available if necessary (consideration of buffer zones, number of applications etc). Uncertainty and natural variability in the components of risk assessment are currently not considered.

• In-field exposure is currently based on application rate and off-field exposure is based on 2-dimensional drift deposition data.

• Here, we show how both in-field and off-field exposure estimates were reviewed and improved through the consideration of application variables, crop architecture, factors affecting drift cloud composition and behaviour, and off-field vegetation. For each, uncertainty and variability were defined wherever possible.

Methods

Exposure scenarios

• Three cropping landscape areas were characterised – in-field, buffer strips and off-field (Figure 1). Selected application/drift and vegetation factors affecting exposure were described and characterised using best available data and, where appropriate, expert judgement. Distributions of variability and/or uncertainty were ascribed where possible.

Application factors

• Factors which were described include: application volume, nozzle type, use of adjuvants, application pressure, windspeed, tractor speed and boom height. A reference application and drift condition allowed for the effect of variables to be investigated, eg nozzle LERAP star rating (Equation 1):

$$D_{noz} = D_{ref}.(1- 0.25.star)$$

Equation 1

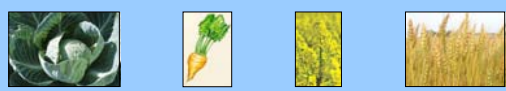
Off-field drift

• Drift was characterised in a 3-dimensional fashion, incorporating estimates of airborne pesticide, necessary when considering interception of drift by vegetation (Figures 2 & 4).

Fig. 2 Simplistic 2-dimensional deposition / 3-dimensional drift interception

Vegetation factors

• Spray/drift interception and surface area for four field crops (shown below) at five BBCH growth stages, buffer strips (grassed or bare) and off-field vegetation (hedges or meadows) were characterised. Growth stage of off-field vegetation was related to that of crop.



Cabbage | Sugar beet | Oilseed rape | Cereals

Characterising variability and uncertainty

• Deterministic risk assessments are based on fixed (often worst-case) values for key variables. Here, such variables were characterised and a suitable distribution type assigned according to the properties of the dataset (eg, continuous or discrete variables). Normal distributions (Figure 3) were defined for variables such as vegetation architecture based on maximum, minimum and mean measurements and variance.

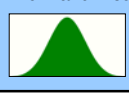
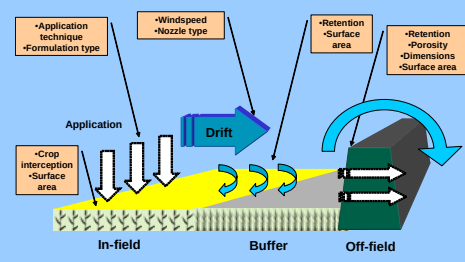


Figure 3 Normal distribution

Fig.1 Exposure scenarios were developed for three main cropping areas: in-field, buffer strips and off-field. Variables may be selected by the end-user and output is exposure for each cropping area in g ai/ha



Results

In-field

• Added realism for in-field exposure estimates – allows user to rapidly assess effects of application and crop variables

• Exposure refinement available by altering application and/or crop characteristics

Off-field

• WEBFRAM realistically considers additional pesticide drift remaining in the air column, currently not included in off-field exposure estimates (Figure 4). However, the influence of partial interception of drift and surface area of vegetation combine to ameliorate this effect. Figure 4 shows a comparison of off-field exposure estimates from both ESCORT 2 and WEBFRAM 4 (Figure 5 – exposures in early and late hedges shown, buffer strip effects not included)

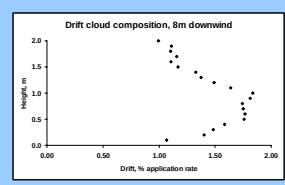


Fig. 4

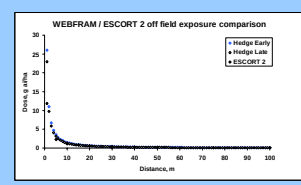


Fig. 5

• The use of unsprayed headlands or grassed buffer strips is potentially a strong option for refinement in arable application scenarios. High proportions of drift are retained by such features further reducing estimates of pesticide drift interception by true off-field vegetation.

• A 1m high grassed buffer strip would intercept approximately 50% of suspended pesticide drift prior to interception by a hedge at a typical buffer strip distance (6-8 m)

Discussion

Benefits

• WEBFRAM represents a significant improvement in realism for NTA exposure assessment

• Relationships between application and vegetation factors have been characterised – these may be improved by the provision of further data

Factors affecting exposure estimates

• In-field – crop architecture, application volume, nozzle type

• Off-field – buffer strip, drift cloud composition (nozzle type, windspeed, application pressure)

Status

•Exposure estimates soon to be incorporated with toxicity refinements to provide web-based user interface

• Avian prototype currently available at www.webfram.com