



Estimating Pesticide Residues on Invertebrates Eaten by Birds and Mammals



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Residues on plants as surrogates for insects

Assessment of pesticide risks to birds and mammals from dietary exposure requires estimates of the concentration of pesticides in their food.

Current approaches rely upon estimates of the residues likely to be found in various types of *plant matter* immediately after pesticide application. These estimates were originally derived by Hoerger and Kenaga (1972). They collated data from field studies with a number of pesticides and derived estimates of the 'Residue per Unit Dose' (RUD), which entered general use in the form of the 'Kenaga nomogram'.

Hoerger & Kenaga's RUDs were revised by Fletcher et al. (1994), based on a much larger dataset. Fletcher's RUDs were adopted in the USA and are being considered for adoption in the EU.

Neither of these studies included any data on residues in insects. Kenaga (1973) suggested that "*residues deposited on insects might be equivalent to those on plant parts of similar surface area to volume ratio*". This suggestion was adopted as standard practice in North America and Europe (Table 1). Until recently, the assumptions it implies were untested.

Table 1. Use of field data on initial pesticide residues in *plant* materials to estimate residues in *insects*. All the values are expressed as the ppm of residues expected per unit of pesticide applied (in lb/acre). To estimate the residue for any pesticide use, the dose rate (lb/acre) is multiplied by the relevant RUD.

Residues measured in:	Kenaga (1973)		Fletcher et al. (1994)		Used to estimate residues in:
	'Typical mean' RUD ¹	'Typical limit' RUD ²	Mean RUD ³	'Upper limit' RUD (approx. 95 th ile) ³	
Forage crops	33	58	45	135	Small insects
Pods / seeds	3	12	5.4	15	Large insects

¹Currently used for risk assessments in Europe (EPP0, 1994). ²Used for risk assessments by US EPA until mid-1990s. ³Currently used for risk assessments by US EPA.

Measured residues on insects

In recent years, residues on insects have been measured in a number of field studies. In principle, these should provide a better basis for RUDs for insects. Three recent studies (by Fischer & Bowers, Brewer et al. and Luttkik) have investigated this approach. This poster summarises a more detailed analysis with a larger dataset that includes more types of pesticides.

Data used in this study

Sources: confidential company studies and published literature

Pesticide type: all but one are insecticides/acaricides, mostly organophosphates or carbamates

Dose rates: mostly 1 - 2 lb/acre

Methods of application: aerial, airblast, boom spray & unspecified

Crops: cabbage, cotton, turf, potatoes, beet, unspecified, apples, citrus, cereal, alfalfa, rape, tobacco, prairie

Number of sites per study: varies from 1 to 33

Country: nearly all USA

Sampling of insects: mostly pitfall trapping

Type of insect: usually not specified - only one study reported separate values for small insects

Sample processing: most pool samples within site

Relationship between RUD and dose rate

The RUD approach implies an important assumption - that the RUD is independent of dose rate. In fact, measured RUDs are about 10x higher than expected at dose rates below 1lb/acre (Figure 1).

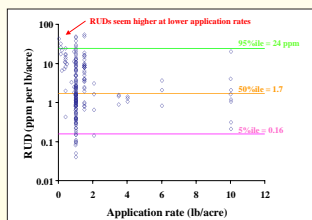


Figure 1. Relationship between measured insect RUDs (Residue per Unit Dose) and dose rate. Each point represents one study site. Higher RUDs are seen for dose rates below 1lb/acre.

Other factors affecting the RUDs

Many of the factors listed above (pesticide, crop, insect type etc) could affect the RUD and may contribute to the non-linearity in Figure 1. However, most studies only included one combination of factors. This makes it impossible to separate the effects of some factors. ANOVA restricted to dose rates between 0.7 and 1 lb/acre indicates significant differences ($P < 0.05$) in $\log_{10}(\text{RUD})$:

- between crops (confounded with application methods)
- between insect types (confounded with sampling methods)
- between pesticides

Factorial experiments would be required to determine which of these factors are really important.

Comparison of insect RUDs with plant RUDs

The 95th percentile for the insect RUDs was 24 (see Figure 1). This is less than the RUD for forage crops which is currently used to estimate residues on small insects in the EU (33) and USA (45 and 135). However, RUDs based on the initial insect residues in this study may cause under-estimation of exposure because:

- in some studies, the maximum residue was not on day 0, but later
- the true relation between application rate and residues may be non-linear
- the data were mainly for live insects collected on the ground by pitfall trapping, but dead insects or those in the canopy may have higher residues
- the data are probably mainly for large insects, but small insects are expected to have higher residues
- the data are heavily dominated by insecticides, which are probably not representative of other pesticides.

Some margin of safety is appropriate to allow for these uncertainties, but it is not easy to judge how large this should be.

Conclusion

Until the factors affecting insect residues are better understood, no firm basis can be given for revising the standard RUDs. Pending further research, it may be best to retain current approaches for screening assessments. Where these indicate a potential risk, field studies could be conducted to obtain more reliable data.

Research needs

1. Field experiments testing the influence of key factors including application rate, insect type and size, time after application, to develop improved RUDs and distributions for probabilistic assessment.
2. Statistical methods for combining pesticide-specific data with generic RUD information, to reduce the need for large numbers of field sites.
3. A practical process for sharing data and updating RUDs as new data becomes available.
4. Re-examination of existing RUDs for plant material to check for similar problems.

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