Compilation and statistical analysis of pollen and nectar pesticide residue concentrations: Applications to Tier 1 and refined Residue Unit Doses (RUDs) for pesticide bee risk assessment

Larry Brewer[1], Timothy Fredricks[2], Silvia Hinarejos[3], Max Feken[4], Tim Joseph[5], Veríssimo Sá[6], William Warren-Hicks[7]

1 Compliance Services International, Lakewood, WA, USA, 2 Bayer CropScience LP, Chesterfield, MO, USA
3 Sumitomo Chemical, Saint Didier au Mont d'Or, France, 4 Syngenta Crop Protection, LLC, Greensboro, NC, USA
5 Landis International, Inc., Valdosta, GA, USA, 6 Corteva Agriscience, Indianapolis, IN, USA
7 EcoStat Inc., Mebane, NC, USA

POLLINATOR RESEARCH TASK FORCE

INTRODUCTION

Honey bee dietary risk assessment of pesticides requires knowledge of the residue levels in nectar and pollen following foliar application to crops, trunk/stem injection application, soil application or seed treatment applications. Current Tier 1 bee risk assessment in the U.S. relies on an exposure estimation and risk assessment model called BeeREX. This model uses a Residue Unit Dose (RUD) approach to estimate residues in nectar and pollen based on the upper-bound pesticide residue values from US Environmental Protection Agency's (US EPA) T-REX model (Version 1.5) of residues measured on a variety of plant matrices (Kenaga Nomogram) assembled for the purpose of dietary risk assessment in birds and mammals. Specifically, the RUD for 'long grass' residues are used in BeeREX as a surrogate for residues in nectar and pollen. In comparison, European Union (EU) Tier 1 risk assessment uses a database of nectar and pollen residue data. The US EPA has recently received residue study datasets, primarily for systemic chemicals, from pesticide registrants, that can be used to adequately describe the temporal pattern of post-application pesticide residue distribution occurring in various plant tissue, including nectar, pollen, leaves and flowers, relative to application rate, application method, and crop group. By combining US EPA chemical-specific plant tissue residue data, for systemic chemicals, into a single compiled database, a statistically refined estimation of RUD values can be calculated. The resulting nectar and pollen RUD values will then inform the BeeREX model with estimated environmental concentrations relevant to bee risk assessment for contemporary pesticides.

DATABASE DEVELOPMENT

To date, the systemic pesticide residue data sets developed in the U.S., as described above, have undergone quality control review and are being combined into a single comprehensive database and an interactive user interface is under development. Authorization from the European Food Safety Authority (EFSA) to include the European RUD Database has been requested but not yet granted. If granted, it will facilitate expansion of the database to also include non-systemic pesticide products.

The user interface will facilitate generation of a single RUD value based on observations across all crop types for a specific application type (*e.g.,* folier, soil drench, seed treatment) and specific plant matrix (e.g., nectar or pollen) similar to the RUD value currently assumed in BeeREXscreening level risk assessments. Additionally, users will be able to generate refined RUD values specific to individual crop groups, application type and matrix for the purpose of refining the Tier 1 BeeREX risk assessment. Table 1 shows the column variables that will be in the database.

Table 1: Database column variables.

Chemical code	% clay	Parent concentration
Formulation	% organic matter	Deg 1 concentration
Treatment #	Crop group	Deg 2 concentration
MRID #	Crop type	Deg 3 concentration
Study I.D.	Variety	Total residues
Study type	Date sampled	**Total Mol. Equivalents**
Trial ID	Sample DALA	RUD (calculated)
Agency submitted to	Matrix	Brix
Site history	1 st Application type	Concentration units
Study location	(foliar, drip, drench, etc.)	Parent LOD LOQ
Study Code	1st application date	Deg 1 LOD LOQ
Study tracking code	1st application rate	Deg 2 LOD LOQ
Soil type	1st application seed trt rate	Deg 3 LOD LOQ
pH	1st application BBCH	Sampling technique
% sand	Interval since last application	Sample I.D.
% silt	(repeat for 12 applications)	

RUD DEFINITION

(mg a.i./kg food item) per 1 kg a.i. applied/hectare

EXAMPLE RUD DATABASE APPLICATION

The primary intent of the RUD database is to provide dependable estimates of residue concentrations in pollinator food resources, primarily nectar and pollen, following selected application scenarios across numerous crops. The residue data will be used to facilitate RUD calculations for use in modeling post-application pollinator pesticide exposure and effects. The database will deploy user-boxes in which users can select variables to generate RUD statistics plus distribution and frequency plots as seen below. The user boxes will have dropdown variable choices in practice. Below input boxes 1A and 1 B both have 1 DALA, foliar application and floral pollen options chosen. Input box 2 A has all crop groups chosen while input box 2B has just the oilseed crop group chosen. The resulting RUD statistics are output in RUD statistics boxes A and B which provide the mean RUD values, standard errors and RUD upper 90% bounds for the selected variables. Distribution and Frequency plots are output to the right of the statistics. ***The data values below are based on simulated data solely for demonstration of the interactive database under development*.**

Input Box 1A

Days After Last Application	
≥ Begin	≤ End
0	1

Note: To select one day(s) after application, type in the same value for Begin/End

Application Type	Foliar
Matrix	Pollen Floral

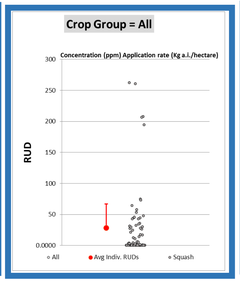
Input Box 2A

Crop Group: All, Bush Berries, Cereal Grain, Citrus Fruit, Cucurbit, Fruiting Vegetables, Legume, Non-grass animal foc, Oilseed, Ornamental, Pome Fruit, Small Fruit/Berries, Stone Fruit, Tree Nut, Tuber

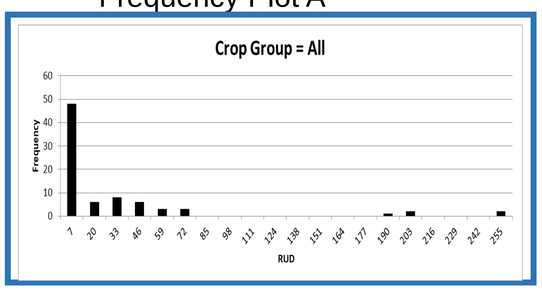
RUD Statistics A

Crop Group = All	
Number of Observations	79
Using Individual RUD	
Mean:	29.76
Standard Error:	6.3
Upper 90% Confidence Interval	40.25

Distribution Plot A



Frequency Plot A



Input Box 1B

Days After Last Application	
≥ Begin	≤ End
0	1

Note: To select one day(s) after application, type in the same value for Begin/End

Application Type	Foliar
Matrix	Pollen Floral

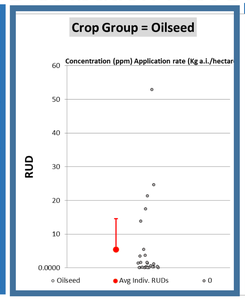
Input Box 2B

Crop Group: All, Bush Berries, Cereal Grain, Citrus Fruit, Cucurbit, Fruiting Vegetables, Legume, Non-grass animal foc, Oilseed, Ornamental, Pome Fruit, Small Fruit/Berries, Stone Fruit, Tree Nut, Tuber

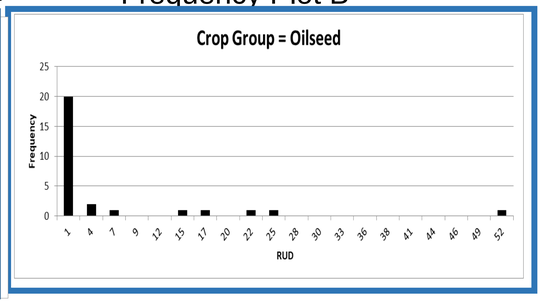
RUD Statistics B

Crop Group = Oilseed	
Number of Observations	28
Using Individual RUD	
Mean:	5.43
Standard Error:	2.18
Upper 90% Confidence Interval	9.15

Distribution Plot B



Frequency Plot B



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