

PestScreen: Screening, scoring and ranking of pesticides by life-cycle impact assessment approach

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Introduction

- Pesticide - Any substance or mixture for preventing or destroying any pest
- Roughly 2.6 million tonnes of active ingredients ~ \$US 38 billion are used annually worldwide
- ~ 90% are used in agriculture
- Applied to protect crops and maintain high yields → contributing to food supply

Introduction

- Pesticides are significant sources of diffuse pollutants that cause health implications upon living organisms including humans
- Due to the risk for human toxicity and environmental ecotoxicity pesticides should be under steady observation

Objectives

- **Method to calculate the relative risk level of pesticides in order to compare substitute compounds through their ranking.**
- **Implement life-cycle impact assessment methodologies and multi-media model calculations into PestScreen.**



Selection of indicators

Dose	Fate	Exposure	Toxicity
Application dose	Degradation half-life	BCF fish	<u>Ecotox. (aquatic):</u> LC50 algae
Frequency	Drift	Intake fraction	LC50 crutaceans LC50 fish
World sales	<u>Leaching:</u> Koc	Kow	<u>Ecotox. (terrestrial):</u> LD50 birds
World use	Solubility		LD50 earthworms LD50 honey bees
	L RTP		
	Overall persistence		<u>Human toxicity:</u> acute: LD50 rat
	<u>Volitalisation:</u> Vapour pressure		acute: LD50 mouse acute: LD50 dog
	Henry's law constant		chronic: ADI



Scoring of indicators

For each indicator the complete dataset (217 chemicals) was divided into four quartiles

Level of concern	Sub-score	Pov (days)
low	1	≤ 44
medium	2	$44 \leq 61$
high	3	$61 < 106$
very high	4	≥ 106

PestScore

$$\text{PestScore} = D \times \underbrace{\left(\frac{\sum F_{i=2}}{2} + \frac{E_{i=1}}{1} + \frac{\sum T_{i=4}}{4} \right)}_{\text{Hazard index}}$$

Level of concern	Class	PestScore
low	I	≤ 2.5
medium	II	$2.5 \leq 5.9$
high	III	$5.9 < 12.0$
very high	IV	≥ 12.0



Results

Summary of screening results

Level of concern	Class	Pesticide class			
		Herbicides	Insecticides	Fungicides	Rest
low	I	15 (22%)	20 (28%)	17 (26%)	3 (25%)
medium	II	8 (11%)	23 (33%)	19 (29%)	4 (33%)
high	III	22 (32%)	13 (18%)	17 (26%)	3 (25%)
very high	IV	24 (35%)	15 (21%)	12 (19%)	2 (17%)
		69 (100%)	71 (100%)	65 (100%)	12 (100%)



Results

Rank correlation between individual indicators

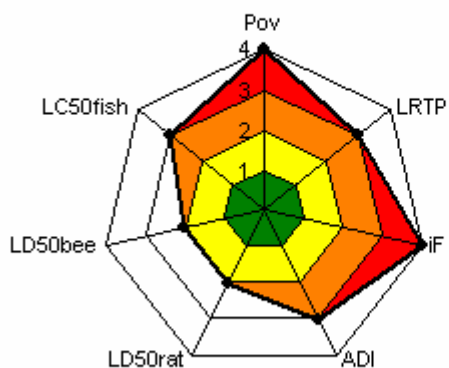
	Dose	Pov	LRTP	iF	ADI	LD50 rat	LD50 bee	LC50 fish
Dose	1.00							
Pov	0.02	1.00						
LRTP	0.21	0.25	1.00					
iF	0.00	0.63	0.34	1.00				
ADI	0.00	0.00	0.10	0.10	1.00			
LD50 rat	0.00	0.00	0.00	0.20	0.62	1.00		
LD50 bee	0.00	0.00	0.00	0.10	0.52	0.67	1.00	
LC50 fish	0.00	0.10	0.00	0.10	0.28	0.33	0.38	1.00



Results

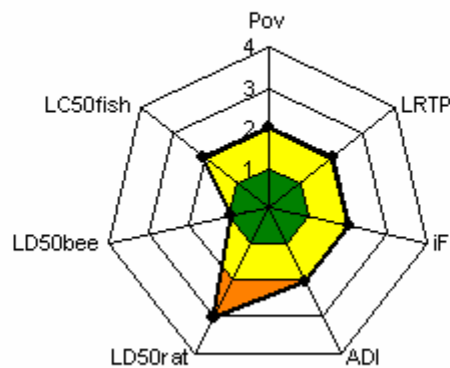
Example1: Fungicides

Fenarimol



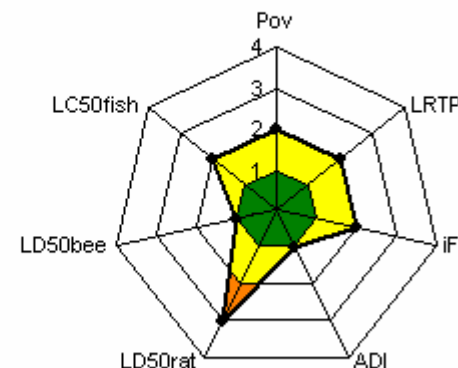
PestScore: 2.0

Myclobutanil



PestScore: 1.2

Triadimenol



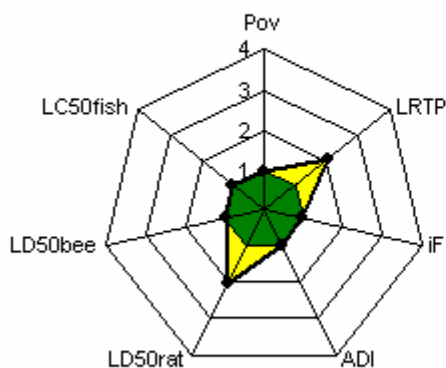
PestScore: 0.6



Results

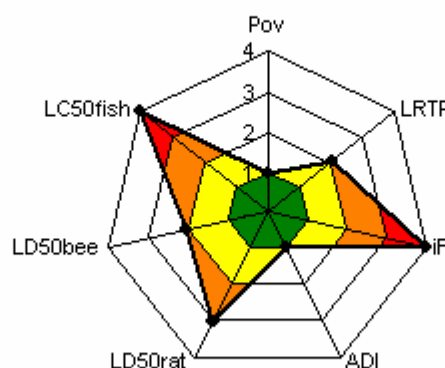
Example2: Herbicides

Glyphosate



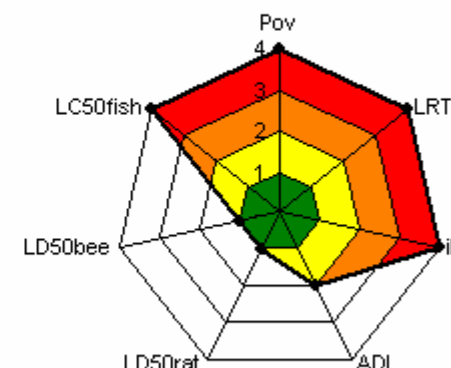
PestScore: 4.5

Pendimethalin



PestScore: 10.4

Trifluralin



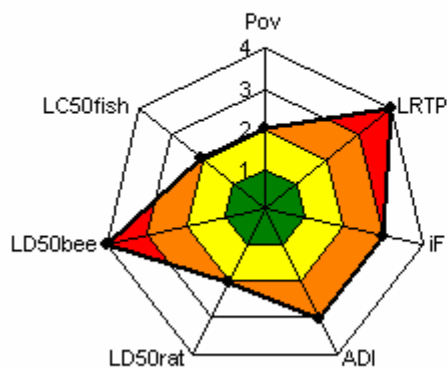
PestScore: 12.5



Results

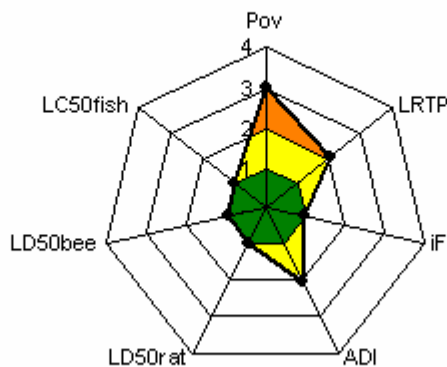
Example3: Insecticides

Buprofezin



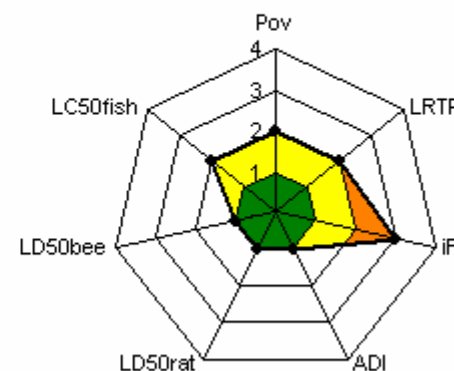
PestScore: 5.3

Pymetrozine



PestScore: 1.4

Pyriproxyfen



PestScore: 1.9



Conclusions

- method may be used for determining the most environmentally friendly active ingredient prior to application
- method allows to compare relative risk of pesticides in terms of human and ecosystem health.
- May lead to better management and decision-making about pesticide use



Questions?