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Adding Realism to Occupational Exposure Assessment of Pesticides using Probabilistic Modelling. A case study on Aggregate Exposure to Pyrethroids.

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INTRODUCTION & AIM

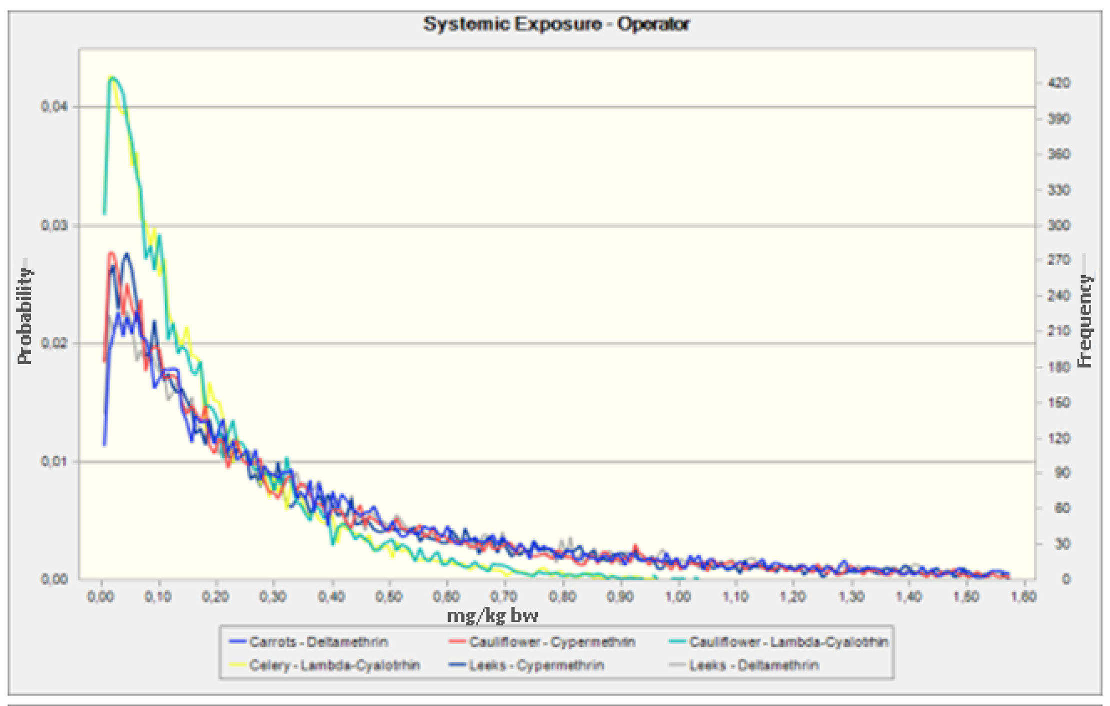
Pyrethroids, a widely used insecticide class, are gaining attention due to increased usage post-restrictions on other types and human biomonitoring levels nearing health effect thresholds. Occupational exposure, especially in PPPs, concerns operators and agricultural workers. EFSA has updated the OPEX tool for non-dietary pesticide exposure assessment. In line with regulatory requirements, the model does not cover aggregate exposures from different uses. This study assesses OPEX's suitability for conducting realistic aggregate exposure estimations, considering that in real life farmers may work on several crops, using probabilistic approaches and data from EFSA-funded projects. The aggregation also considers the exposure to several pyrethroids.

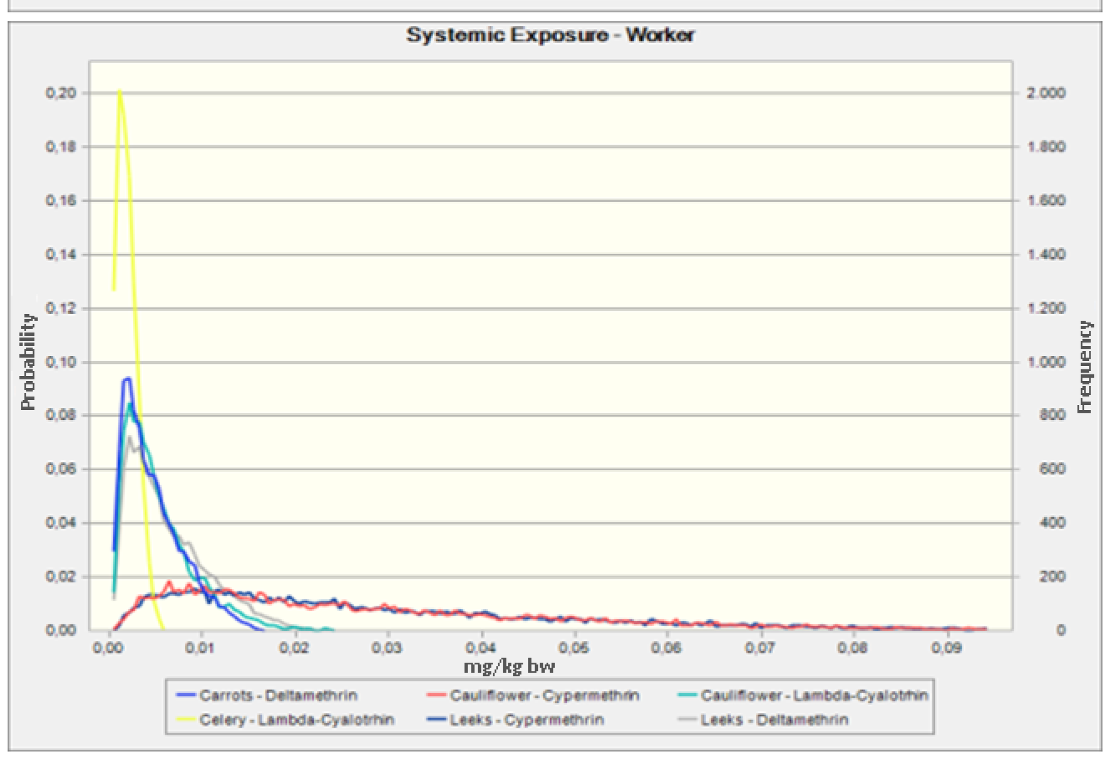
METHOD

The EFSA OPEX tool prioritizes tasks relevant to pyrethroid use in PPPs, integrating workflows for operators and workers. Three scenarios were selected for this study, operator exposure, worker exposure, and operator and worker exposure in an eight-hour shift. Cypermethrin, lambda-cyhalothrin and deltamethrin were selected, and exposure levels were evaluated in the following crops: cauliflower, celery, artichokes, leeks and carrots. A Monte Carlo simulation replaced individual parameter by distributions, guided by EFSA data and expert input, to estimate daily exposure probabilities. A sensitivity analysis was included. This is a "Proof of Concept" and will add other variables, e.g., use of protective equipment, in the next steps.

RESULTS & DISCUSSION

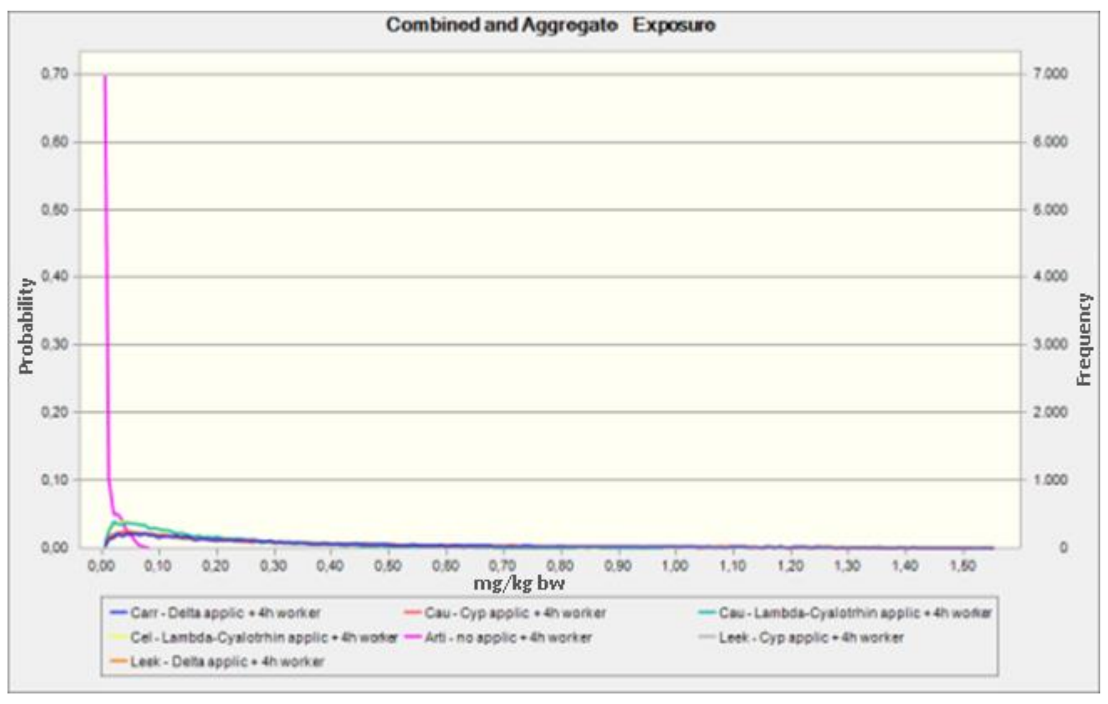
SENSITIVITY ANALYSIS (%)			
OPERATOR	**Body Exp**	**Dermal Abs**	**Treated Area**
Cauliflower - Cypermethrin	52,7	25,4	21,6
Cauliflower - Lambda-Cyhalotrhin	67,1	4,8	27,5
Celery - Lambda-Cyhalotrhin	66,2	6,3	28,1
Leeks - Cypermethrin	51,6	25,6	22,3
Leeks - Deltamethrin	58,2	18,3	23
Carrots - Deltamethrin	57	18,3	24,2
WORKER	**Appl Rate**	**Dermal Abs**	**Time**
Cauliflower - Cypermethrin	9,7	51,7	38,2
Cauliflower - Lambda-Cyhalotrhin	37,3	12,3	50
Celery - Lambda-Cyhalotrhin	5,8	18,8	75
Leeks - Cypermethrin	9,5	52,7	37,5
Leeks - Deltamethrin	3,7	45,4	50,5
Carrots - Deltamethrin	3,7	45,6	50,3



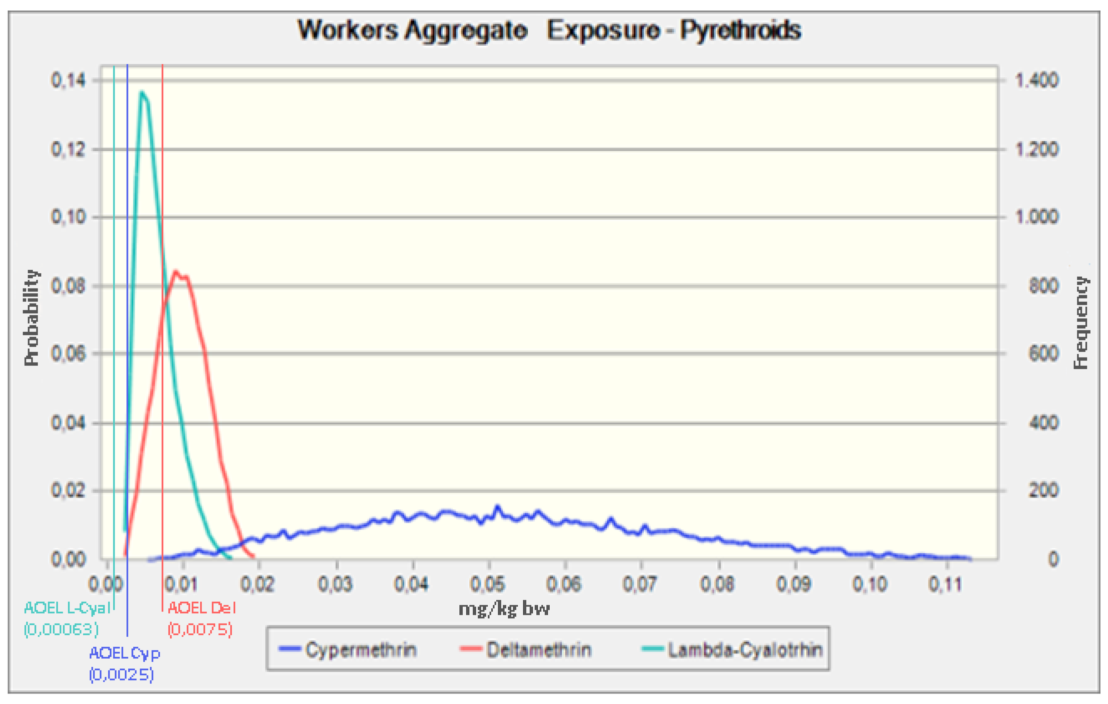


The charts show the estimated probabilistic occupational exposure to pyrethroids in operators (top figure) and in workers (bottom figure). The estimations do not consider the use of protective equipment, and consequently exposure estimations are significantly higher for operators' activities than for the workers. Exposure patterns are similar for operators, while for workers, the patterns differ with the scenario; with the broadest distributions estimated for cypermethrin uses.

The accompanying table shows a sensitivity analysis indicating the contribution of the different parameters to the overall variability. External exposure leads the variability for operators, while dermal absorption and the size of the treated areas have different patterns for each pyrethroid, with dermal absorption adding more variability than the area size for cypermethrin, and the opposite for lambda-cyhalothrin and deltamethrin. For workers, exposure variability for cypermethrin is led by dermal absorption, while the amount of time spent in the area has the highest influence for lambda-cyhalothrin and deltamethrin.



This chart illustrates the combined and aggregate exposure of a single worker to various pyrethroids used on different crops throughout an eight-hour workday. The scenario assumes the worker spends half the day applying a pyrethroid and half a day as worker in other crops. As no protection equipment is included, the additional exposure as worker (pink line artichoke scenario not applying the selected pyrethroids) only represent a minimal contribution to the combined exposure.



This chart shows the estimated aggregate exposure for each pyrethroid, considering the uses in several crops. Cypermethrin stands out with a significantly smoother curve. This is driven by the wider range of application rates used for cypermethrin compared to lambda-cyhalothrin and deltamethrin.

CONCLUSION

Current tools assess exposure to pesticides by crop and task. As in reality the same person may be exposed from different crops and tasks, methods for aggregate exposure are needed. This study proposes a new method to assess the aggregate/combined exposure from different sources and exposure routes (e.g., inhalation, skin contact). Pyrethroids have been selected for the case study as the dietary exposure of EU adults is close to the levels of concern, and therefore it is urgent to conduct aggregate exposure estimations to identify potential risks related to the aggregate exposure from the diet and occupational sources.

The results of the present approach will serve as a case study for future studies aiming not only to refine the occupational exposure assessments to pesticides when the realistic conditions of use/exposure are known, but also to identify cases of concern when aggregate exposure is considered and strengthen the foundations of risk evaluation in pesticide exposed occupational settings.

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