Plant uptake studies for refining chemical exposure assessments

Original thinking supporting chemical exposure assessments

Plant Uptake Factor Assessment facility - providing our partners with more options to reduce chemical risk, by bringing together **Radiochemistry, Plant Growth & Modelling knowledge** to support chemical regulatory assessments

The regulatory landscape

The Plant Uptake Factor (PUF) is used in Environmental Fate Models such as **PEARL, PELMO or PRZM** to represent the proportion of chemical absorbed into the plant via the roots. The magnitude of the PUF value can significantly affect the mass of chemical available in the soil pore water and subsequently the predicted concentrations in soil leading to the leaching potential in groundwater.

Current guidance recommends a default value of '0' is applied to the models (FOCUS, 2014).

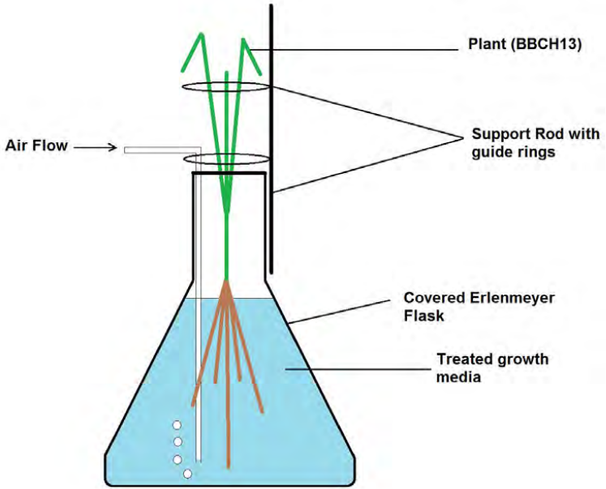
- At present, applicants can only justify using a **Plant Uptake Factor (PUF)** value that has been experimentally measured
- Plant uptake leads to a decrease of compound mass in the soil system and thus diminishes the amount of substance available for leaching. Leaching models simulate plant uptake by considering the soil water consumed by plants, the concentration of a substance freely available in the soil water (which is the result of sorption and degradation processes considered separately in the models) and the parameter "**Plant Uptake Factor" (PUF)** sometimes attributed as **Transpiration Stream Concentration Factor (TSCF)**
- Correct implementation of the plant uptake process in the **FOCUS** leaching models is an important factor in the regulatory assessment of many substances

Let's talk science

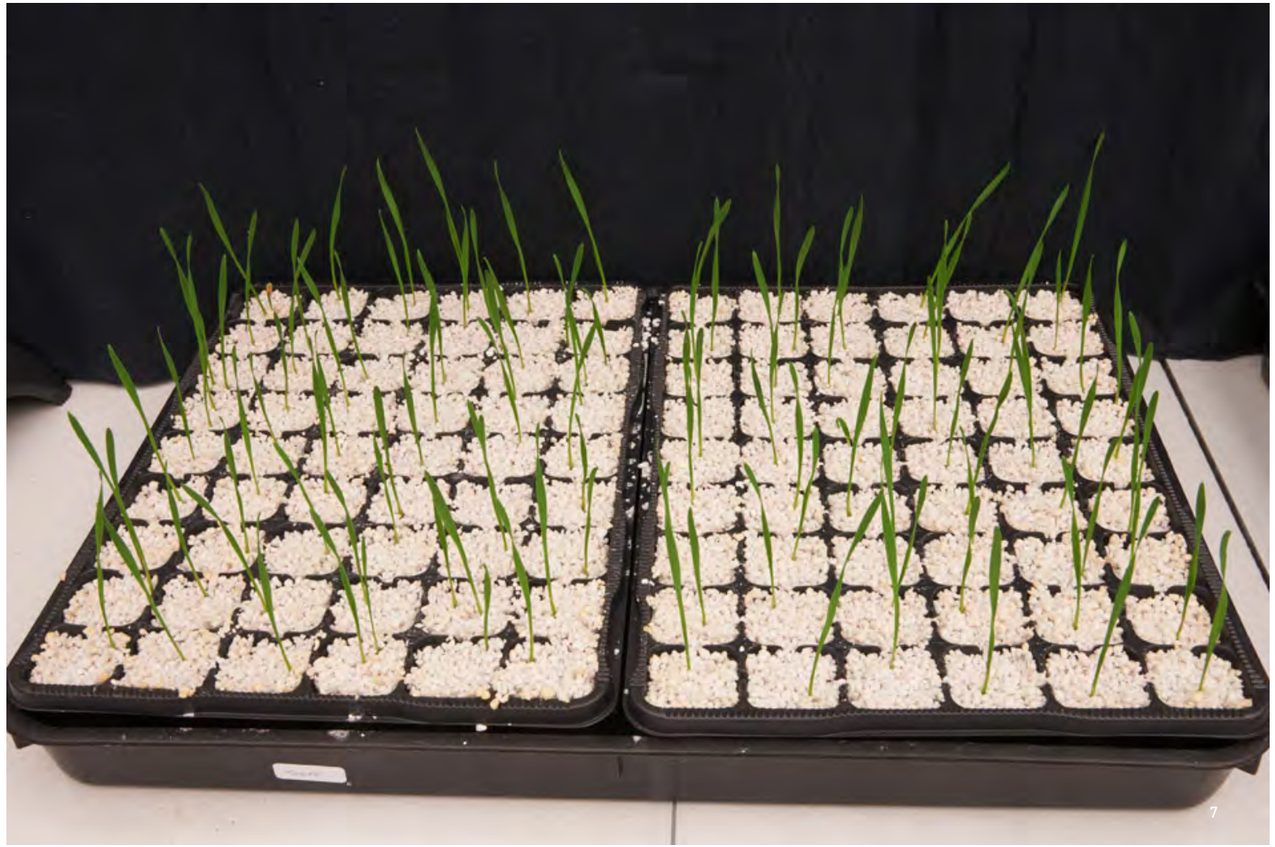
The Biologische Bundesanstalt bundessortenamt und chemische industrie (BBCH) scale used to identify the phenological development stages of a plant, have been developed for a range of crop species.

Our experimental design uses individual plants (e.g. wheat, maize or tomato) grown in germination substrate to the BBCH 12 stage. At this stage the substrate is washed from the roots and the plants are transferred to flasks for the pre-conditioning phase until BBCH 13. Replicate plants are selected and vessels are accurately dosed with a radio-labelled test compound.

The incubation time is set to minimise plant stress and the time for degradation of the test items whilst allowing for a sufficient transpiration volume. We remove aliquots for analysis at 0, 2, 5 and 8 days after treatment.



- The PUF for individual test items ranged from <0.1 to 0.9
- The measured PUF can be used in the Environmental Fate Models of the European Union to estimate potential ground and surface water concentrations of Plant Protection Products
- The PUF is typically used in regulatory environmental fate modeling of pesticides such as PEARL, PELMO and MACRO to simulate uptake of chemicals from soil solution. The magnitude of the PUF value can significantly affect the mass of chemical available in the soil pore water and subsequently the predicted concentrations in environmentally relevant compartments



Product and services

Our new validated tests and services cover all agrochemical legislations facilitating successful PPP registrations.

The Plant Uptake Factor experiment is designed to give chemical manufactures that have a regulatory responsibility the option to reduce ground water risk. High ground water concentrations are of concern as organisms within the direct ecosystem are then exposed to potentially toxic chemicals. There is also the risk of these chemicals entering our water system and contaminating drinking water.

To understand this risk and the potential for environmental contamination, Plant protection products (PPP) and their metabolites are assessed using a number of laboratory experiments. These experiments track the transformation, distribution and dissipation within a variety of environmental compartments.

Fera has been a key participant into standardised IVA/ECPA protocol design with the main objectives being to propose a new standardised, validated test design to drive Plant Uptake Factors (PUF) for regulatory leaching models.

Using our GLP compliant hydrophonic system to evaluate a more accurate plant uptake factor enables you to estimate potential ground and surface water concentrations of your **Plant Protection Products** and refine your chemical exposure, aiding that more successful path to registration.

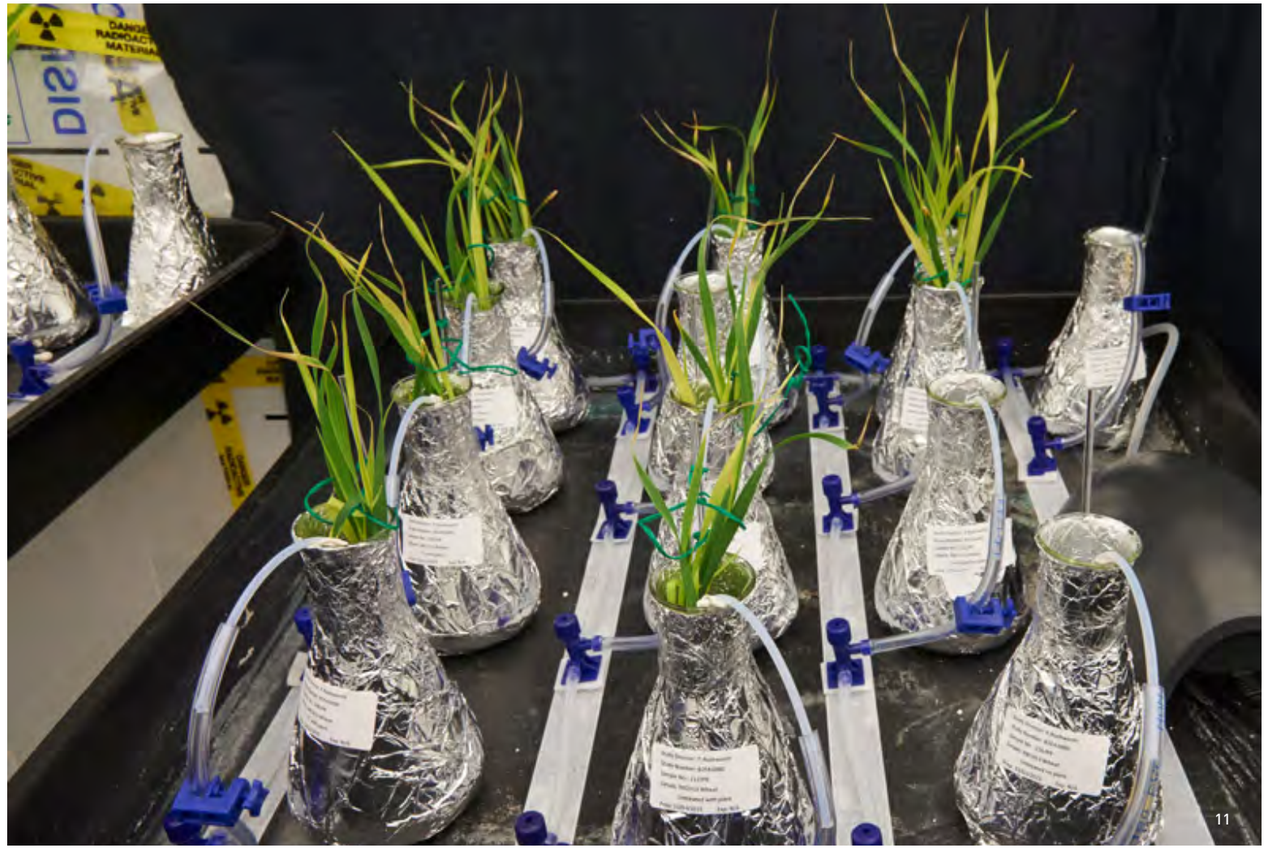
Products, services and techniques

Our laboratories are equipped with state-of-the-art facilities that enable cost-effective performance of GLP compliant environmental fate studies for pesticides, veterinary medicines, pharmaceuticals and industrial chemicals to satisfy regulatory requirements including;

- Laboratory (GLP) analytical services for agrochemicals, REACH, veterinary medicinal products
- Laboratory studies with radio-labelled and non-radiolabelled chemicals
- Batch sorption including aged sorption and column leaching studies according to OECD guidelines and parameter estimation
- Soil, water-sediment and manure/slurry biodegradation studies including estimation of degradation parameters and endpoints
- Hard (man-made) surfaces fate studies including lab-scale sorption, wash-off, and field monitoring studies
- Design, interpretation and analysis of lysimeter, field leaching, field dissipation and environmental (e.g. groundwater) monitoring studies

We can also undertake bespoke studies investigating the fate of chemicals under non-standard scenarios performed to GLP standards for registration purposes.

Make it happen.



Case study - getting partners products to market

Plant protection products (PPP) and their metabolites are assessed using a number of laboratory experiments. These experiments provide understanding of the risk of the chemicals entering the water system and contaminating drinking water by tracking the transformation, distribution and dissipation within a variety of environmental compartments.

The Challenge - our client had performed the standard experiments for the assessment of their PPP and had identified a significant metabolite (>10%) occurred during the soil transformation assessment (OECD 307). Further environmental testing on this metabolite identified that it had high mobility (OECD 106) and was moderately persistent (OECD 307).

This generated a major issue for our client as it indicates that post application of the parent PPP in the field, this metabolite will be formed during the degradation and is highly likely to leach into ground water. Computer aided modelling indicated that levels would be above the standardised trigger level of 10 µg/L in the ground water generating an unacceptable risk.

To generate the predicted levels in ground water, our client is hindered by the fact a default PUF value of '0', i.e. no uptake, must be used at the modelling stage if no experimental data is available (FOCUS 2014).

Fera performed a PUF assessment on the metabolite of interest and we were able to prove that in reality the metabolite was up taken by the root system of three different crops under laboratory conditions. Fera used three different commercial crops which were a mixture of monocotyledon and dichotomous species to ensure that a robust justification for the results being used in the modelling could be made for a board application PPP. The PUF values ranged between 0.3 and 0.5 for the three crops investigated.

Our client was then able to justify altering the PUF value within the modelling phase and significantly reduce the concentrations within groundwater yielding an acceptable risk. This helped in supporting the client meet regulations and contributed towards getting their product to market.

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