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Ionizing radiation has been reported to cause adverse effects in different primary producers including both autotrophs and heterotrophs. Upon exposure, high dose rates of ionizing radiation can reduce reproduction and growth, cause damage to DNA and other biomolecules. However, the physiological responses and toxicity mechanisms occurring at low doses and dose rates are still poorly understood in aquatic plants. This study aimed at characterizing the biological effects of ionizing (gamma) radiation from a cobolt-60 (^{60}Co) irradiation source using a combination of Mode of Action (MoA) characterization and determination of adverse (apical) effects in duckweed (*Lemna minor*). Chronic toxicity was assessed as inhibition of growth after 7 days exposure to 1-70 mGy/h according to the OECD test guideline 221 (OECD,2006). The MoA of gamma radiation was determined as oxidative stress (ROS and lipid peroxide formation) and DNA damage in combination with physiological responses such as oxidative phosphorylation (OXPHOS) and Ca^{2+} release, photosystem II (PS II) activity, CO_2 assimilation, antioxidant responses (total GSH), and pigment changes (Chlorophyll *a*, Chlorophyll *b* and carotenoids). The results indicated that changes to tGSH, pigments, CO_2 uptake, Ca^{2+} release and DNA occurred at dose rates between 1 and 14 mGy/h, whereas ROS formation and lipid peroxidation (LPO) together with decrease in OXPHOS and growth parameters were only observed at dose rates of 24 mGy/h and higher. An Adverse Outcome Pathway (AOP) network was developed to portray causal relationships between gamma radiation induced physiological responses and adverse outcomes in *L. minor*.

TU129

Simple CA and IA models underestimate the phytotoxicity of micropollutants caffeine and nonylphenol

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Given the prevalence of micropollutants in aquatic systems, the assessment of mixture effects is vital to a complete understanding of the effects of chemicals in the environment. Caffeine and nonylphenol are among the most commonly detected micropollutants in freshwater systems but come from different chemical classes and differ greatly in their individual potencies. Two major models dominate the assessment of mixture toxicity: concentration addition (CA), which is typically applied to chemicals with the same mode of action, and independent action (IA), which is applied to chemicals with different modes of action. Single chemical tests and an equitoxic binary mixture test were performed with the aquatic macrophyte *Lemna minor* to assess the potential for interaction between these commonly co-occurring chemicals. Seven day exposures were conducted with endpoints including frond number, frond area, fresh weight and chlorophyll content. Concentration-response curves from the single chemical tests were used to select equitoxic mixture ratios for the mixture test, and the results were then compared to the predicted mixture effect based on CA and IA models. In the single chemical tests, caffeine did not have high phytotoxicity on its own, indicating effects at environmental concentrations are unlikely. The toxicity of nonylphenol was greater but limited by nonylphenol's water solubility and associated with higher variability. Significant growth inhibition, tissue necrosis and chlorophyll alterations were detected at only one order of magnitude from the highest reported environmental concentrations, suggesting environmental effects from nonylphenol exposure are possible. IA underestimated the toxicity of the caffeine-nonylphenol mixture by at least a factor of two at all effect levels. CA also underestimated the mixture toxicity, but the model deviation ratio was under two for the tested effect levels and wide confidence intervals overlapped with the mixture regression obtained from experimental data. Based on these results, synergistic interaction between caffeine and nonylphenol is possible. However, CA cannot be ruled out as an effective model if the uncertainty could be reduced. The ambiguity of the results indicates the difficulty of choosing suitable mixture models in non-ideal cases.

TU130

Modelling growth of Lemna exposed to Metsulfuron-methyl using a dynamic energy budget approach

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The exposure of pesticides are dynamic and variable in time. However due to the complexity of the exposure profile, it is not possible to study every exposure in a laboratory experiment. To allow extrapolation to any predicted exposure profile, we model effects on growth using a simplified dynamic energy budget model (based on DEBkiss). This model is a mechanistic approach relying on mass and energy balance, which is suitable for the sublethal toxicity endpoint growth. We compare our model's performance with another *Lemna* model, developed by Schmitt et al. 2013. As a case study, we consider the sulfonyl-urea herbicide Metsulfuron-methyl (MSM).

TU131

Old herbicide in new light: filling the data gap of mecoprop-p for dicotyledonous macrophytes

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The fate and concentrations of the auxin phytohormon herbicide mecoprop-p (MCPP-P) in the aquatic environment is well documented but little toxicity data of dicotyledonous aquatic macrophytes have been published so far over the last decades. To fill up this data gap, the German Environment Agency (UBA) conducted a microcosm study in order to test the sensitivity of 10 different macrophytes (mainly dicotyledonous species). Ten macrophyte species (*Callitriche palustris, Ceratophyllum demersum, Hottonia palustris, Hydrocotyle leucocephala, Hydrophila polysperma, Ludwigia repens, Myriophyllum spicatum, Nymphoides peltata, Ranunculus aquatilis*, and *Veronica beccabunga*) were exposed to MCPP-P in 7 concentrations ranging from 8 μg/L to 512 μg/L for 21 days in each one microcosm. Two further microcosms served as controls. For each species, ten individuals were planted separately in plant pots, which were filled up with 2 layers of sand (bottom and top) and a middle layer of a mixture of commercial pond soil and sand. Plant preparation and endpoints were adapted to each species but in general fresh weight, dry weight, length of main shoot, and number of leaves/whorls were measured at the start and at the end of the experiment. Eight species proofed to be sensitive to MCPP-P. For 5 species it was possible to generate EC_{50} values ranging from 47 to 444 μg/L MCPP-P with *M. spicatum* being one of the most senstive species. On base on data of this study, it was possible to construct a species sensitivity distribution (SSD) model combining other published data. The results will be critically discussed. Our test confirms the reliability of the use of *M. spicatum* as representing dicotyledonous species, as it proved to be one of the most sensitive species in our study for the tested auxin herbicide. Regarding the new low RAC concentration of MCPP-P, it has to be highlighted that uses like in bitumous roofing felts are not in the focus of any regulation so far. This application, however, can lead to high run-off concentrations entering surface waters exceeding the RAC values.

TU132

Macrophyte Toxicity Testing: Influence of Growth Form on Sensitivity

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The importance of macrophytes in maintaining biodiversity in the ecosystem cannot be understated. They provide food, habitat and affect the physical and chemical properties of aquatic systems. The current guidance on tiered risk assessment for plant protection products for aquatic organisms in edge-of-field surface waters involves performing toxicity test on macrophytes, green algae, additional non-green algae, and on *Lemna* species. In case the herbicide simulates a plant growth hormone or if *Lemna* species is not sensitive to the herbicide, then testing with *Myriophyllum spicatum* is recommended. Testing on *Glyceria maxima* is also recommended in case the action of the herbicide is primarily on monocots. Furthermore, additional aquatic plants can be tested in case the uncertainties in the outcome of the risk assessment were high in order to refine the risk assessment process. In the current study, toxicity tests were performed using six rooted aquatic macrophytes. These were namely *Myriophyllum aquaticum, Hygrophila polysperma, Limnophila sessiliflora, Callitriche pallustris, Nasturtium officinale and Heteranthera zosterifolia.* These aquatic plants can grow emersed for example during periods of drought and for example submersed during flooding. Also the different forms can be built in the same habitat. Based on these findings, the different growth forms of these species were tested. The aquatic plant species were obtained from commercial sources and adapted in both their emersed and submersed states prior to the test. 3,5-Dichlorophenol (DCP) was used as the test substance and the EC_{50} of the mean growth rates and yields were determined and compared for each species. The results obtained showed that, the different growth forms of the plants had an influence on the sensitivity of the plant species to the test substance. Preliminary results also indicated that, most aquatic plant species which were adapted to the emersed state demonstrated lower sensitivity to 3,5-DCP compared to those adapted to the submersed state.

TU133

A draft OECD Test Guideline for the emergent macrophyte, Glyceria maxima, in a water-sediment system: results of a ring-test with Imazapyr

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Data requirements introduced under EU Directive 1107/2009 stipulate that tests with aquatic plant species other than *Lemna* may be required for plant protection products which show selectively higher toxicity to either dicotyledonous or monocotyledonous plant species in terrestrial plant tests. In these cases, the recommended dicot and monocot species are *Myriophyllum* and *Glyceria*, respectively. OECD Test Guideline 239 for testing *Myriophyllum spicatum* in a water-sediment system was adapted to facilitate growth of the emergent, reed grass, *Glyceria maxima*, and ring-tested in 13 laboratories during 2016 and 2017