Energy Crop Summer Rape (*Brassica napus* L.) as a phytoextractor of Cd at Different Soil Moisture Content

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In the remediation of heavy metal pollution and the management of industrial and/or municipal waste and their sites, efforts are being made to use more environmentally friendly, low-cost, and investment alternatives. Phytoremediation is a bioremediation process that uses various types of plants remediate contaminated soil and water. Phytoremediation, which can be used effectively in advanced waste management, is potential alternative to traditional treatment methods (Sharma et al., 2018). For example, it can be used to manage various metal-contaminated landfills of electrical and electronic equipment (Luo et al., 2018), pulp and paper industry waste, industrial or municipal sewage sludge (Placek et al., 2016; Sharma et al., 2020). An integrated sustainable method is proposed, which combines phytoremediation treatment with energy processing, in accordance with the principles of circular economy. In this way, using energy crops for phytoextraction and phytomining (recovery of valuable elements) solves the problem of removing contaminated biomass while lowering treatment costs. (Pandey et al., 2016). Also, soils intended for the cultivation of energy crops are exempt from the HM limit values. *Brassica napus* belongs to *Brassicaceae* family and also is an energy crop. It has the ability to collect large quantities of HM in its tissues, although it's relatively resistant to heavy metals, but growth might be restricted at high concentrations of heavy metal or non-optimal environmental conditions (Rossi et al., 2002; Marchiol et al., 2004). However, there is a lack of information on the sensitivity of phytoremediation to climatic factors (Worthy et al., 2013; Simon, 2015). Our aim was to evaluate the growth of energy crop summer rape (*Brassica napus* L.) in soil contaminated with one the most toxic heavy metals - Cd at different soil moisture contents.

A bioremediation mesocosm experiment was performed in the greenhouse. Summer rape *(Brassica napus* L) growth is evaluated at different Cd concentrations in soil (0, 1, 10, 50, 100, 250 mg/kg-1). 54 vegetation pots were divided into 3 different groups of soil moisture: normal/control (25-30 % WHC), drought/deficit (40 % WHC), flooding/excess (60 % WHC). Different effects of soil moisture content were simulated for a little bit more than 2 weeks, until then normal moisture content was maintained for all pots. 3 replicates of all soil moisture content variants for each Cd concentration were performed. Vegetation pots were rotated every day to minimize any potential chamber effects on plant performance. After experiment, plant's aboveground part (shoot) height and underground part (root) length, fresh and dried mass was measured. Tolerance index (TI) was defined as the ratio between the dry matter yield of the plants in contaminated soil in relation to the dry matter yield of the plants from unpolluted soil.

In conclusion, after evaluating the energy crop summer rape (*Brassica napus* L.) growth in soil contaminated with Cd at different soil moisture content, our results showed that soil moisture content has a significant effect to plant growth in Cd contaminated soil. Which could have an influence on worse summer rape (*Brassica napus* L.) Cd tolerance. For better growth during phytoremediation process and possible higher efficiency in soil with hight heavy metal contamination, normal soil moisture content should be maintained. Although, it can be stated that energy crop summer rape (*Brassica napus* L.) has good potential to be used in phytoremediation. It can grow in soil contaminated with Cd, biomass increasement is visible below 100mg/kg^{-1} which is an advantage for energy crop, also it has tolerance to Cd contamination below 250 mg/kg^{-1} concentration, but soil moisture has statistically significant effect to plant growth. Further analyses of soil moisture content and different environmental factors impact not only to plant growth, but also to Cd bioaccumulation in plant tissue and translocation must be conducted.

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