Energy Crop Summer Rape (*B. napus* L.) Phytoremediation Potential at Different Soil Moisture Content

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Heavy metal (HM) contamination of environment is currently a major worldwide problem. Constantly growing industrialization and other anthropogenic activities contributes to the pollution of heavy metals, which are not biodegradable and cause serious negative impacts on human health and environment (Rodrigues et al., 2013; O'Connor et al., 2019; Alengebawy et al., 2021). Phytoremediation is a potential alternative to traditional waste and contaminated sites treatment methods that can be used effectively in advanced sites management with significant advantages (Sharma et al., 2018). Phytoremediation technique consumes less energy than traditional technologies and harvests a valuable resource by producing biomass. The energy crop *Brassica napus* is a member of the *Brassicaceae* family, which are particularly good hyperaccumulators used for phytoremediation (Park et al., 2012). Although *B. napus* is relatively resistant to heavy metals, it has the capacity to accumulate large amounts of HM in its tissues. However, B. napus growth may be constrained under high heavy metal concentrations or non-optimal environmental conditions. Also, because of the lengthy removal process, the effectiveness of phytoremediation is also dependent on-site environment and its management (Marchiol et al., 2004; Hou et al., 2017). It is expected that soil moisture content variation with ongoing climate change will have an impact on plant biomass production and soil pollutant behaviour, and it will affect phytoremediation. The sensitivity of phytoremediation to climatic factors, however, is not well understood The purpose of this study was to determine how soil moisture content affects the potential of the energy plant summer rape (*B.napus* L.) to phytoremediate Cd-contaminated soil.

A phytoremediation mesocosm experiment was performed in the growth chamber in the precisely controlled environment: 21/14 °C day/night temperature, 14 h/10 h photoperiod, 400 ppm CO_2 concentration, 55–60/65-70% day/night relative humidity and photosynthetically active radiation of ∼300 µmol m^{-2} s^{-1} photon flux density. The Cd concentration range was selected to simulate Cd content in soils representing background, slightly contaminated, and severely contaminated sites such as mining and waste disposal areas. Soil was spiked with cadmium chloride $CdCl_2$ solution to get final Cd concentrations in the soil: 0, 1, 10, 50, 100 and 250 mg Kg^{-1} Plants were subjected to three different soil water content (SWC) treatments: normal (control) SWC 30 %, reduced SWC 10 % and elevated SWC 40 %.

B. napus demonstrated strong resistance to Cd toxicity as well as the capacity to phytoextract Cd from the soil. While Cd removal effectiveness was determined by rape growth and Cd soil concentrations, Cd accumulation in oilseed rape increased with Cd soil concentration. *B.napus* coped well with low and moderate Cd pollution (with tolerance index TI>0.69), whereas high Cd soil pollution had a significant negative impact on plant growth (it was reduced by up to 90%), resulting in low Cd removal efficiency. Plant growth, Cd accumulation, and removal from the soil were all influenced by SWC. Oilseed rapes grown in elevated SWC had higher biomass than those grown in reduced SWC, though the adverse effect of Cd was more severe at higher SWC. Elevated SWC increased Cd bioaccumulation, whereas reduced SWC resulted in a decreased Cd bioaccumulation. The highest Cd removal efficiency is guaranteed by the optimal SWC, whereas a lack of or excess of soil water limits B. napus phytoremediation potential and prolongs removal process.

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