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## Introduction

- An integrated sustainable method is proposed, which combines phytoremediation of heavy metal 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.
- However, there is a lack of information on the sensitivity of phytoextraction to climatic factors.
- 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.

## Materials & methods

- Experiment was carried out in the greenhouse for a little over 6 weeks for different soil contaminations with Cd (0, 1, 10, 50, 100, 250 mg/kg<sup>-1</sup>). Air temperature averaged 21.1±0.02°C during the day. Normal moisture content was maintained 4 weeks for all pots.
- After that all 54 vegetation pots were divided into 3 groups of soil moisture by Water Holding Capacity (WHC): normal (40 % WHC), drought (25-30 % WHC), flooding (60 % WHC). Different soil moisture content effects were simulated for 17 days. 3 replicates of all soil moisture content variants for each Cd concentration were performed.
- After experiment plant growth was evaluated - shoot height and root length, fresh and dried weight 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.

## Results & discussions

- Factorial analysis of variance (ANOVA) has shown that both Cd concentration and soil moisture content had significant effect on summer rape (*Brassica napus* L.) shoot height (Cd F=155.84 p<0.05; WHC F=115.73, p<0.05; Cd x WHC F=6.27, p<0.05).
- Soil moisture content had a significant effect on root length (Cd F=2.11, p>0.05; WHC F=23.32, p<0.05; Cd x WHC F=1.54, p>0.05).
- Cd concentration in soil and moisture content had significant effect on shoot DW (Cd F=7.93, p<0.05; WHC F=47.91, p<0.05; Cd x WHC F=1.27, p>0.05) and root DW (Cd F=5.17, p<0.05; WHC F=46.20, p<0.05; Cd x WHC F=1.30, p>0.05).



Picture 1: mesocosm experimental site of Cd phytoextraction using summer rape.

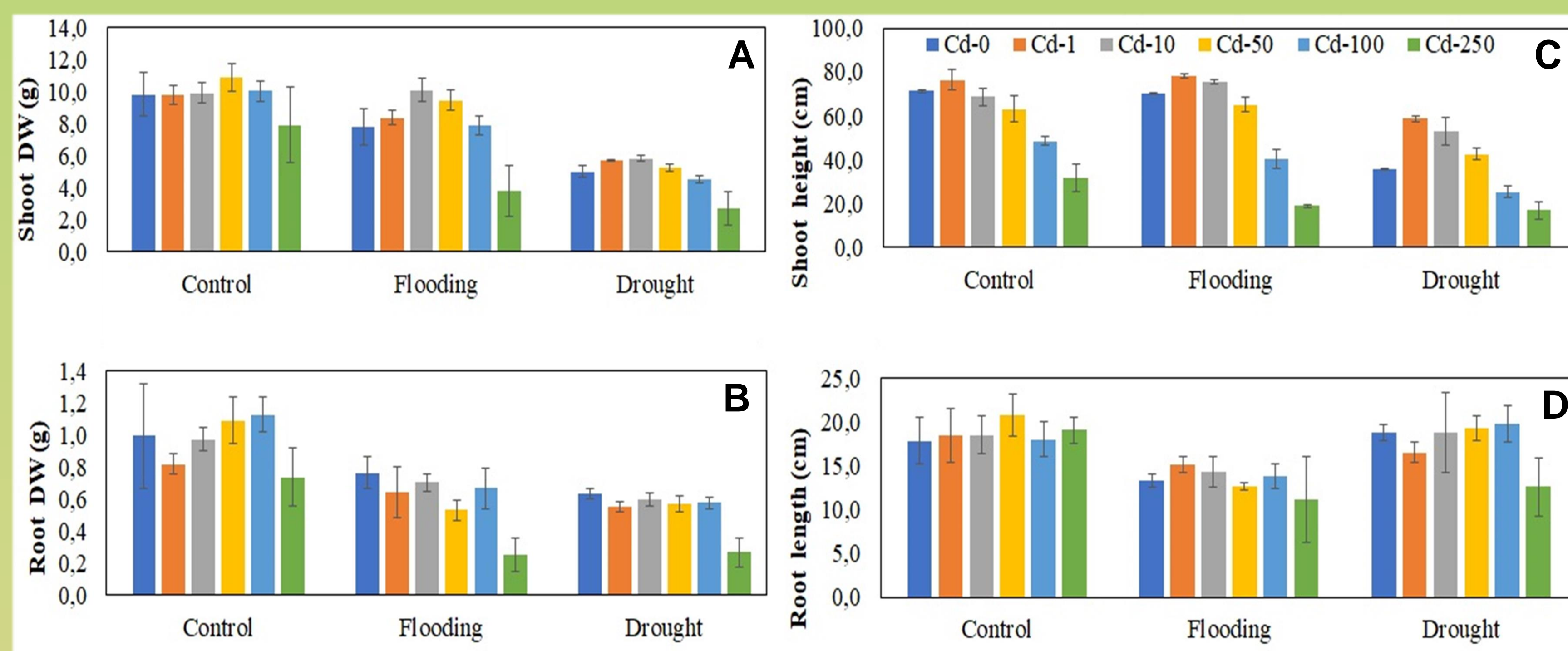


Figure 1: Summer rape growth characteristics in different Cd concentrations and soil moisture contents: shoot DW (A), root DW (B), shoot height (C), root length (D).

- Cd concentration in soil and moisture content had significant effect on summer rape tolerance to Cd soil contamination (Cd F=16.12, p<0.05; WHC F=14.52, p<0.05; Cd x WHC F=2.76, p<0.05).

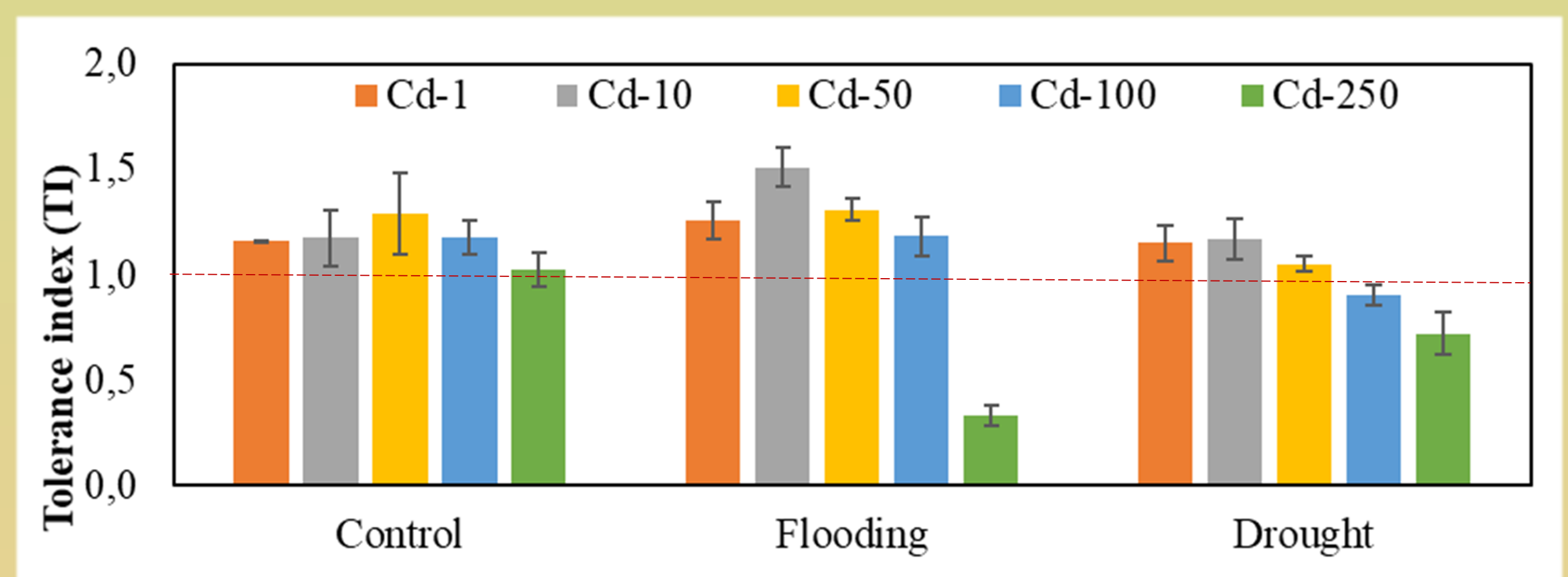
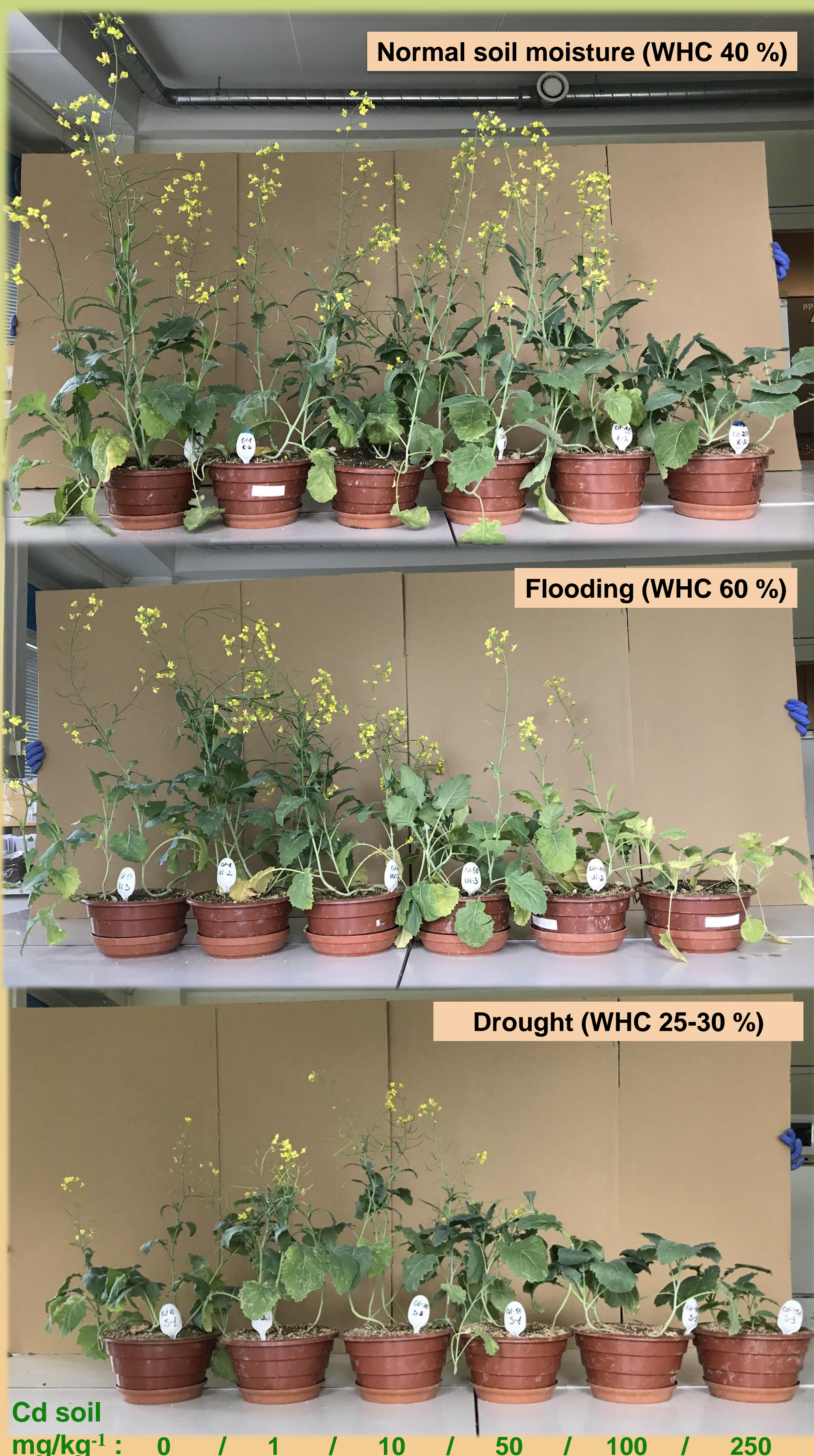


Figure 2: Summer rape (*Brassica napus* L.) tolerance index (TI) during phyto remediation in different Cd concentrations and soil moisture contents.

## Concluding remarks

- ✓ Energy crop summer rape has good potential to be used in phyto remediation as Cd phytoextractor. Higher biomass production is visible for some Cd concentrations in soil, which is a big advantage in the use of energy crops.
- ✓ Soil moisture content has a significant effect on plant tolerance and growth in Cd contaminated soil. To achieve a better growth and possible higher phytoextraction efficiency in soil with high heavy metal contamination normal soil moisture content should be maintained.
- ✓ Further analyses of different environment factors impact not only to plant growth, but also to Cd bioaccumulation and translocation must be conducted.



Picture 2: Summer rape biomass variation after phytoextraction experiment at different soil moisture contents and Cd concentrations.