

MANIPULATING SOIL Cd BIOAVAILABILITY THROUGH CHANGING SOIL pH AND ORGANIC MATTER

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background

- **plants absorb Cd mainly from the soil**, where the concentration is different due to the different distribution in the earth's crust and the history of the soil management (fertilization)
- the content of **Cd in the plants depends mainly on the concentration of the available Cd in the soil**
- **solubility of Cd in soil and the subsequent uptake by plants is affected by a variety of soil chemical and physical factors**, i.e. OM, pH, oxides and other cations in the soil
- in Slovenia **several samples of vegetables exceeding the limit value of Cd** were detected, anyhow **the soils where these vegetables were grown did not contain excessive concentrations of Cd**, but usually have low pH and are low in OM
- **high proportion of arable land in Slovenia has low pH**
- **in-situ immobilization of Cd by amendments** is one of the most widely adopted methods to remedy soil contamination

activities

- in autumn 2021 a set up of a long term experiment on the field where excessive contents of Cd in carrot were determined

Soil characteristics, depth 0-30 cm (april 2021)							Cd in garlic, mg/kg FM (august 2021)	Limit mg/kg FM
Location	Texture	pH	Organic matter %	CEC mmol+/100 g	Cd total mg/kg	Cd available mg/kg		
Gradišče	SL	5.4	1.6	10.87	0.294	0.013	0.077-0.174	0.05

- soil amendments (lime, zeolite and organic matter) are tested for their potential to reduce the Cd bioavailability and subsequent the Cd content in 4 garlic varieties and, from 2024 on, also in 4 potato varieties

methodology – treatments, set-up

- soil amendments: lime 3 t/ha (0-4 mm, pH 9.4, ECCE 55.3%, Cd 0.65 mg/kg)
 - lime 3 t/ha + 1 t/ha zeolite (0-4 mm, pH 7.9, ECCE 2.3%, Cd 0.09 mg/kg)
 - lime 3 t/ha + organic matter (2022 green rye incorporation in summer, 2023 wheat straw incorporation in autumn)
- garlic varieties: Garpek
Messidor
Gardos
Ptujski jesenski
- split plot – soil amendments main factor, variety subfactor
- 4 replicates

methodology - agricultural practice

mid Oct: soil sampling; lime and zeolite application; fertilizer (NPK) application
end Oct: soil cultivation
begining Nov: planting of garlic
begining March: fertilizer (N) application
Jun 22: rye mulch on AOM treatment
Oct 23: wheat straw on AOM treatment
end jun – begining Jul: harvest of garlic



methodology – analysis

➤ soil characteristics:

pH, organic matter, CEC, total and bioavailable Cd
0-15 + 15-30 cm

before planting each autumn and subsequent summer
at harvest (mixed sample of all repetitions of the treatment)

➤ garlic:

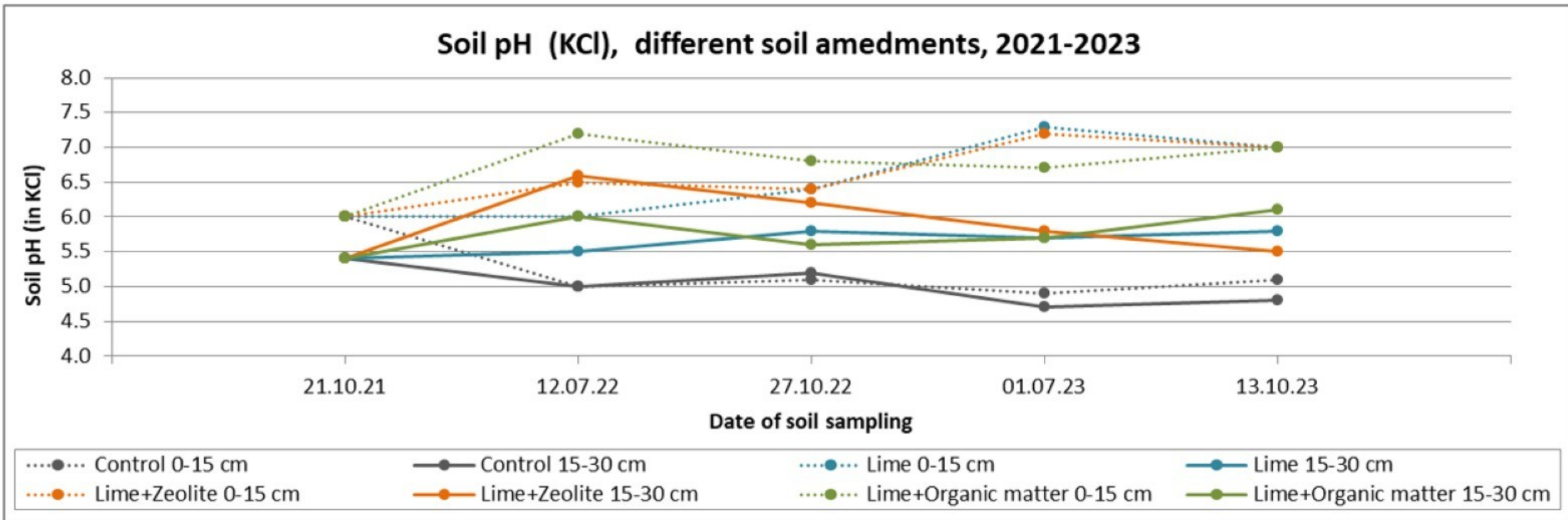
Cd content, DM
each plot separately

➤ other inputs - fertilizers:

Cd content
pH



results – soil pH

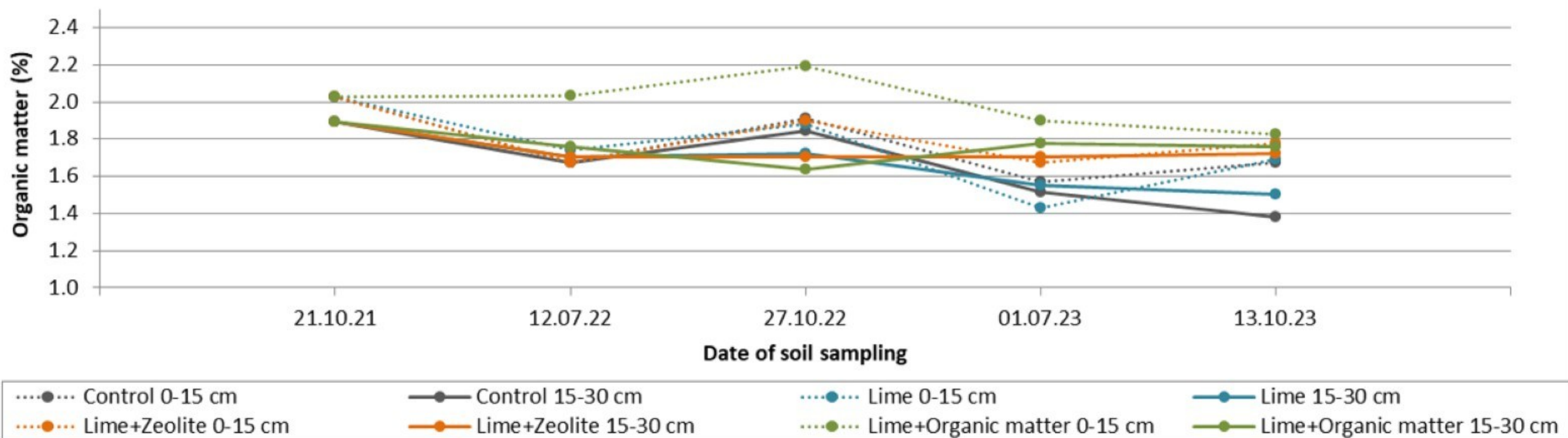


control – slightly decreasing at both depths

lime, lime+zeolite, lime+OM – increase at both depths, stronger at upper level

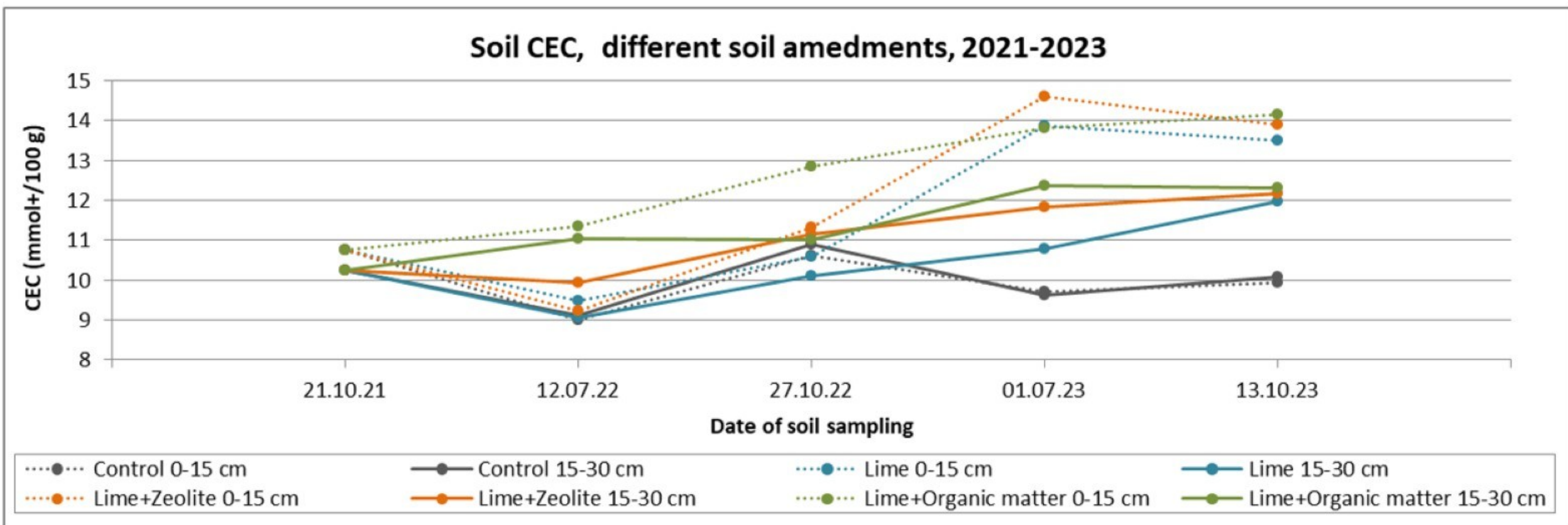
results – soil OM

Soil organic matter, different soil amendments, 2021-2023



control, lime, lime+zeolite – slightly decreasing at both depths
lime+OM

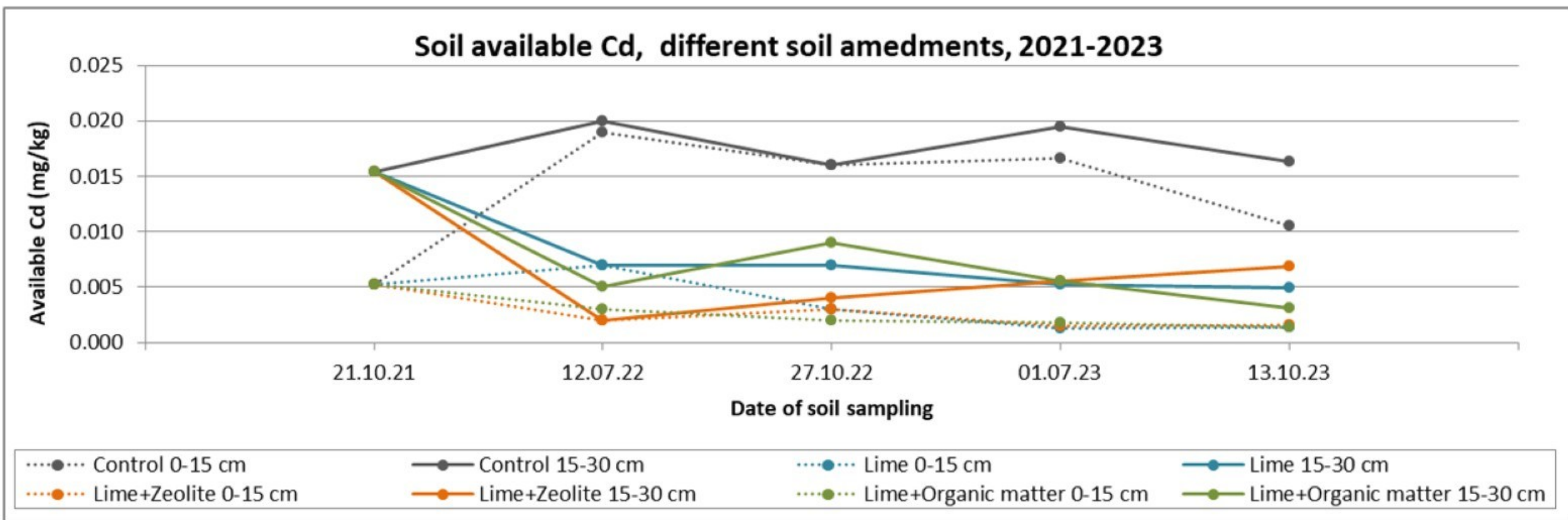
results – soil CEC



control – seasonal changes between 9 and 11

lime, lime+zeolite, lime+OM – at both depths trend of increasing, stronger at upper layer

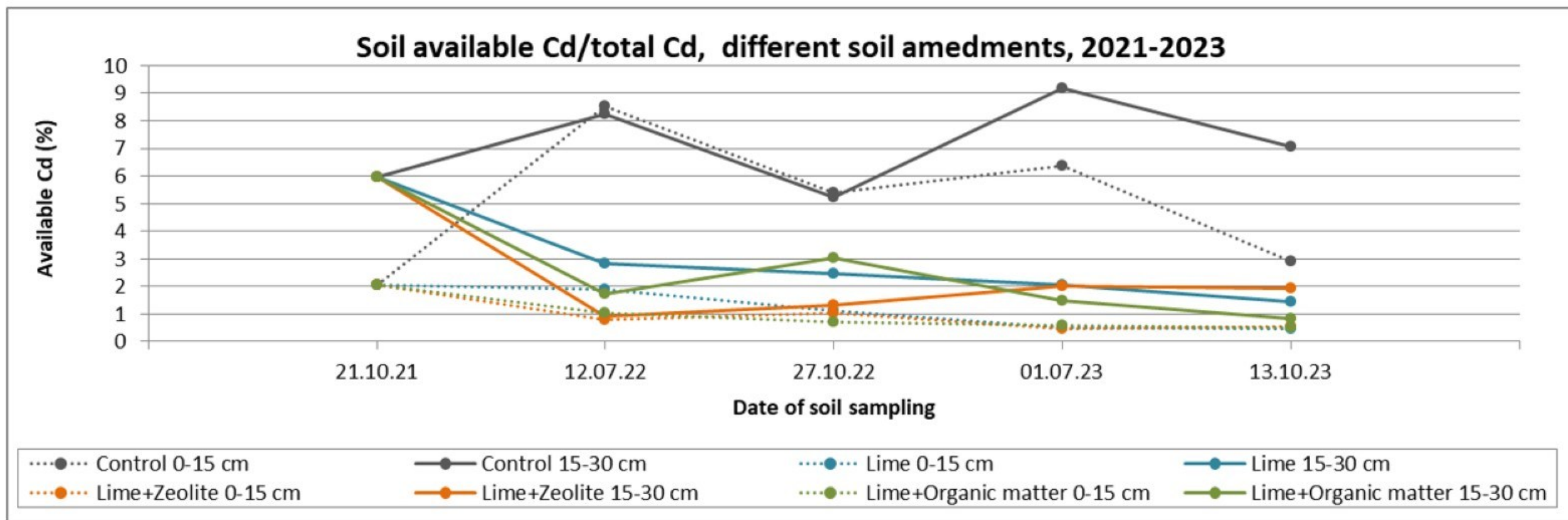
results – soil available Cd



control – slight seasonal changes, stays between 0.01 and 0.02 mg/kg

lime, lime+zeolite, lime+OM – at both depths trend of decreasing, stronger at upper layer

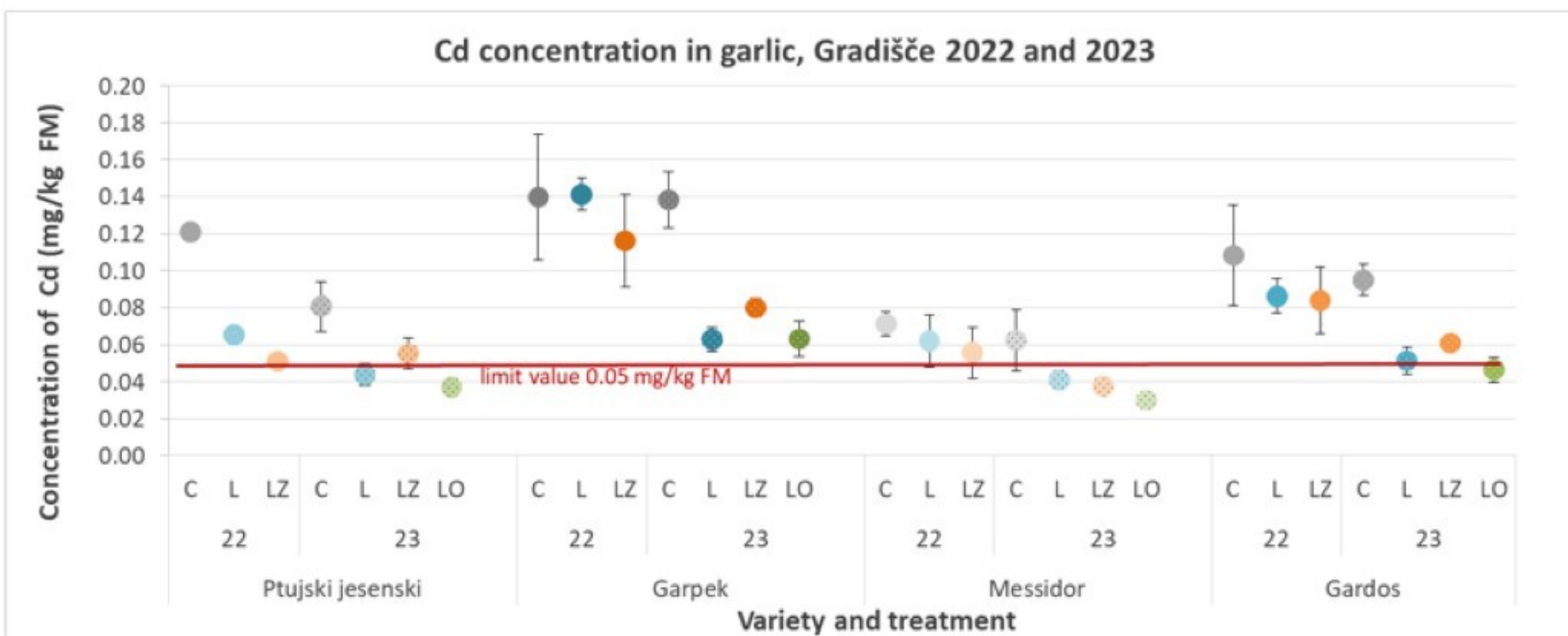
results – soil available Cd %



control – sesonal changes between 5 and 9 %

lime, lime+zeolite, lime+OM – trend of decreasing, at upper layer fallen below 1 %, at lower depth 1 to 2 %

results – garlic Cd



significant differences between varieties, Garpek always above the limit, Messidor always the lowest concentrations

control - no differences between the years, all samples above the limit value

lime, lime+zeolite – trend of decreasing of Cd concentration

lime+OM – the lowest concentration for all varieties

conclusions

After the 2 years of applying the same treatments (soil amendments)

- the application of lime, lime+zeolite and lime+organic matter significantly influenced the soil properties – increased pH and, at the OM treatment, also the content of OM, increased the CEC and reduced the available Cd
- the effects of amendments were stronger at the upper soil level (0-15 cm), but were noticeable also in the layer 15-30 cm
- the significant effect of all amendments on reduction of Cd content in garlic cloves was achieved, anyhow the reduction of the content of Cd in garlic cloves below the limit of European Commission Regulation 2023/915 was observed with variety Messidor at all treatments and applications with varieties Ptujski jesenski and Gardos at the treatment lime+OM