UNIVERSITÀ DEGLI STUDI DI PADOVA

Investigating hydrogel potentialities for improving soil pore network by using X-ray computed microtomography

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Background

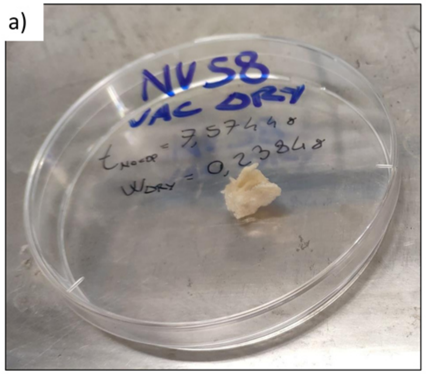
- Hydrogels (**HGs**) are conventionally defined as a natural or synthetic polymeric 3D networks with high hygroscopicity and water-swelling properties

- **HGs** unique physical properties, *e.g.*, **porosity** and **swellability**, make them ideal platforms for water and nutrient delivering. For these reasons, increasing attention has been given to HGs for agronomic purpose

- The **aim** of this study was to investigate the potentialities of two HGs for improving **porosity of three soil types**

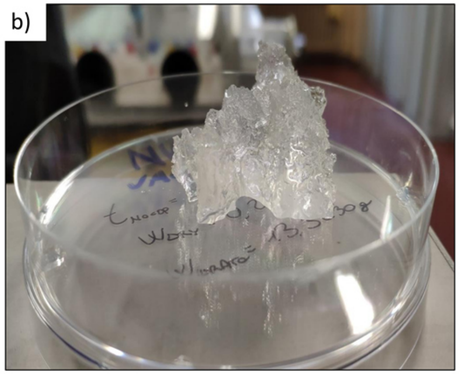
Dry hydrogel

a)



Swollen hydrogel

b)

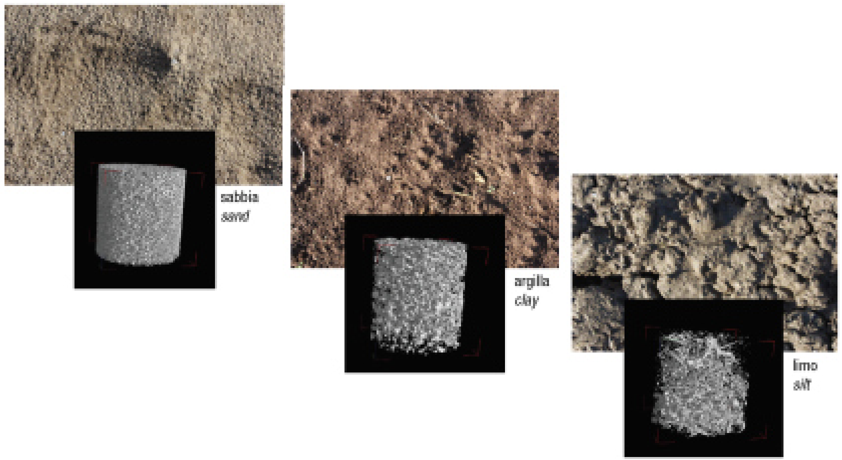


Materials & methods

2 HGs types («H30» and «commercial») were mixed with 3 different soils («sand», «silt» and «clay»)

HG type	Composition	Weigth fraction (w/w)
H30	Carboxymethyl cellulose, humic acids, clay	4 ‰
Commercial «C»	Polyacrylamide	4 ‰

Soil type	Bulk density (g/cm^3)
Sand	1.65
Silt	1.45
Clay	1.2



Materials & methods

Soil core equilibration

-50 cm → Saturation → -50 cm → Saturation → -50 cm

Saturation → -50 cm → Saturation

Freezing and drying (at -80°C)

Acetone → drying → Acetone → drying → Acetone → drying

X-ray scan

at 50 μm resolution

(100 mA and 100 kV)

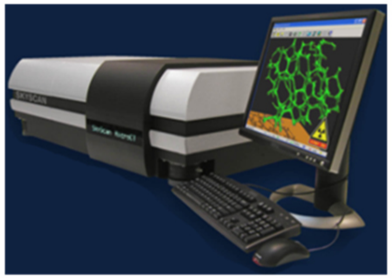
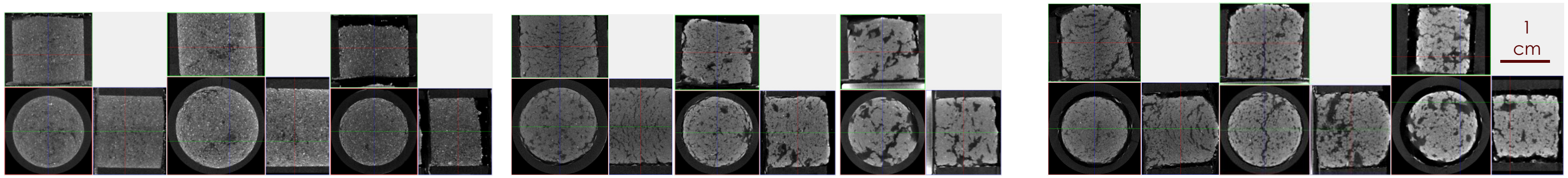


Image analysis

total porosity (TP), mean diameter (MD), connectivity density (CD), degree of anisotropy (DA), pore size distribution

Results

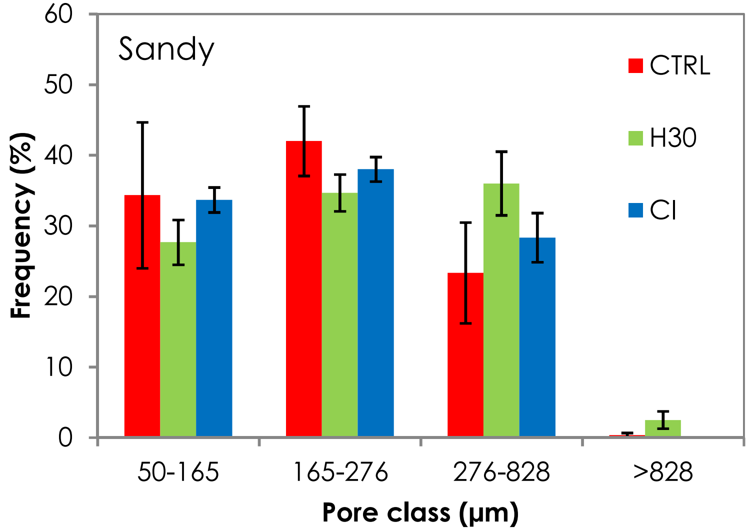


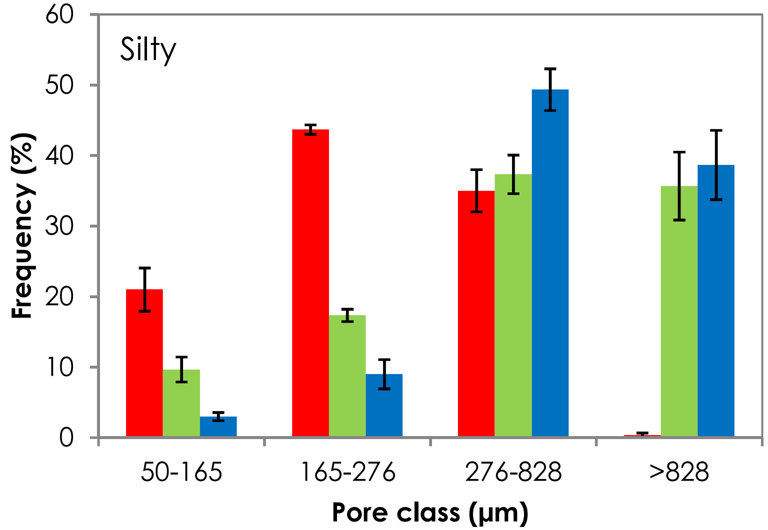
	Sandy			Slty			Clay		
	CTRL	H30	C	CTRL	H30	C	CTRL	H30	C
TP (%)	0.98	1.16	0.77	3.6	10.5	17.3	5.13	10.21	8.72
MD (µm)	217	282	233	247	691	770	404	568	568
CD (μm^{-3})	6.20E -06	7.66E-06	4.05E-0.6	1.25 E-05	1.70E-0.5	1.99 E-0.5	1.26	1.63E-05	1.24E-05
DA	0.64	0.51	0.45	0.66	0.51	0.35	0.58	0.36	0.39

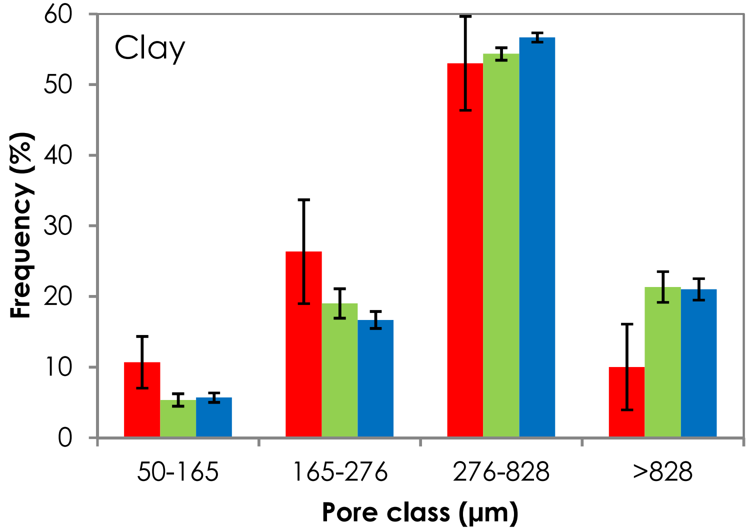
TP: total porosity; MD: mean diameter; CD: connectivity density; DA: degree of anisotropy

- **HGs** increased TP and MD depending on soil types, observing higher increase in silty and clay soils
- **HGs** did not affect pore morphological indices (CD and DA)

Results



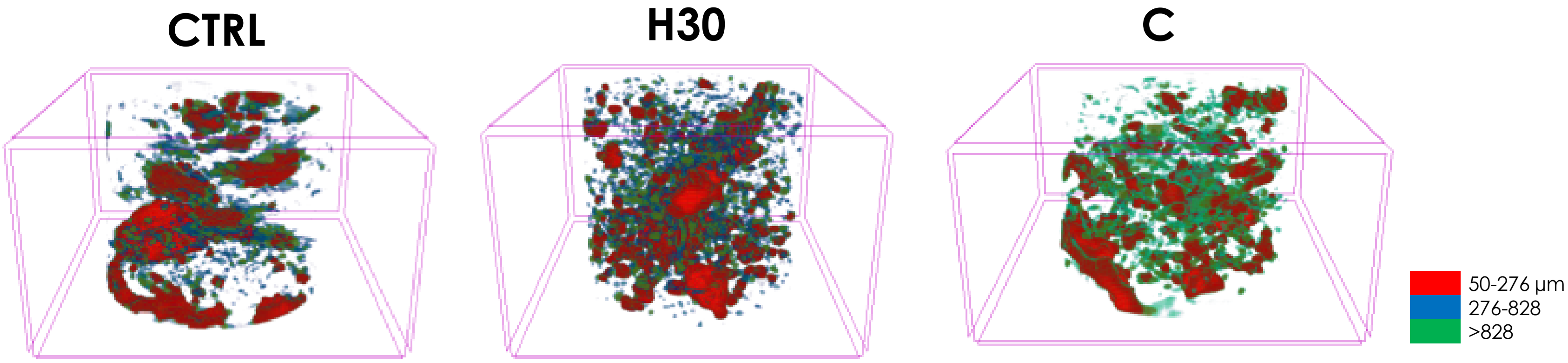




- **HGs** affected the pore size distribution irrespective of soil type
- H30 and commercial HG positively affected the higher diameter pore classes (*e.g.*, pores > 276 µm)

Conclusions and prospectives

- Present study demonstrated that in fine-textured soils at high water content, HG might be a valuable tool to increase not simply the TP but, in particular, the macroporosity fraction which may play a key role in soil functioning and ecosystem services



- Future research will investigate the HG performances under dynamic soil moisture conditions on water holding capacity and hydraulic conductivity

Thank you for the attention

InnoGel project

http://wwwdisc.chimica.unipd.it/innogel/

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