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Enhancing photosynthetic efficiency and nutrient uptake in maize (*Zea mays* L.) using extracellular polymeric substances recovered from waste sludge

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BACKGROUND

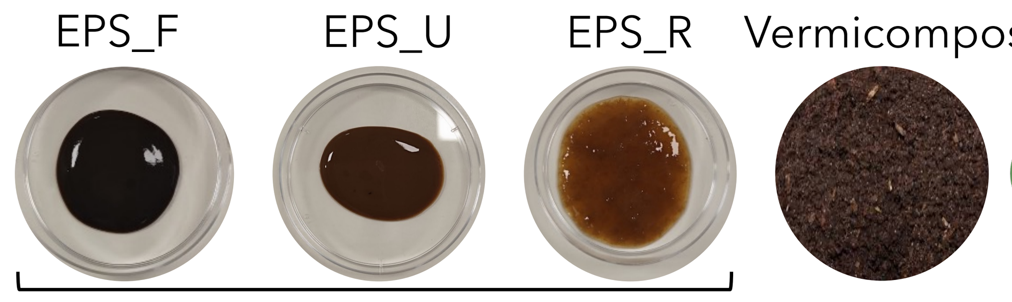
Extracellular polymeric substances (**EPS**) can be recovered from waste aerobic granular sludge (AGS) generated during biological wastewater treatment. These biopolymers are rich in organic carbon and nutrients and can improve the water-holding capacity of soils, making them suitable for agricultural applications.

AIM

Evaluate the effects of incorporating different sources of EPS as soil amendments on the growth and nutritional traits of maize

METHODS

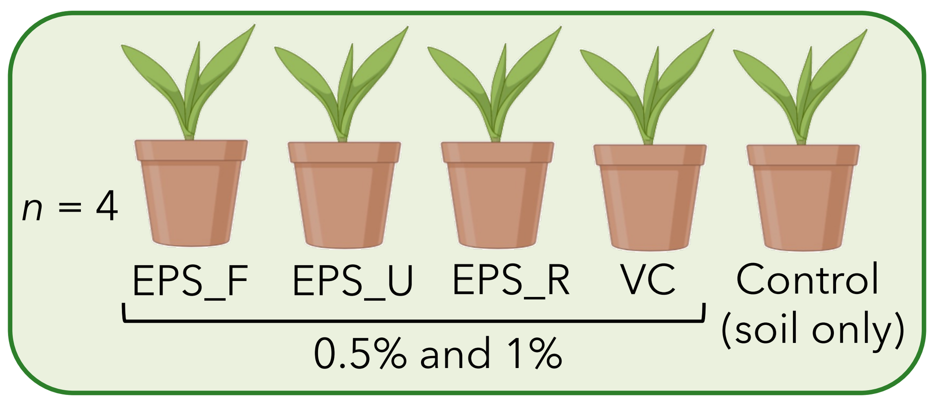
Greenhouse pot experimental setup



EPS recovered from waste AGS sourced from two WWTPs (Faro – F, and Utrecht - U) and a lab-scale reactor – R.

Both amendments were applied at doses of **0.5%** and **1%** (w/w)

Plant analyses

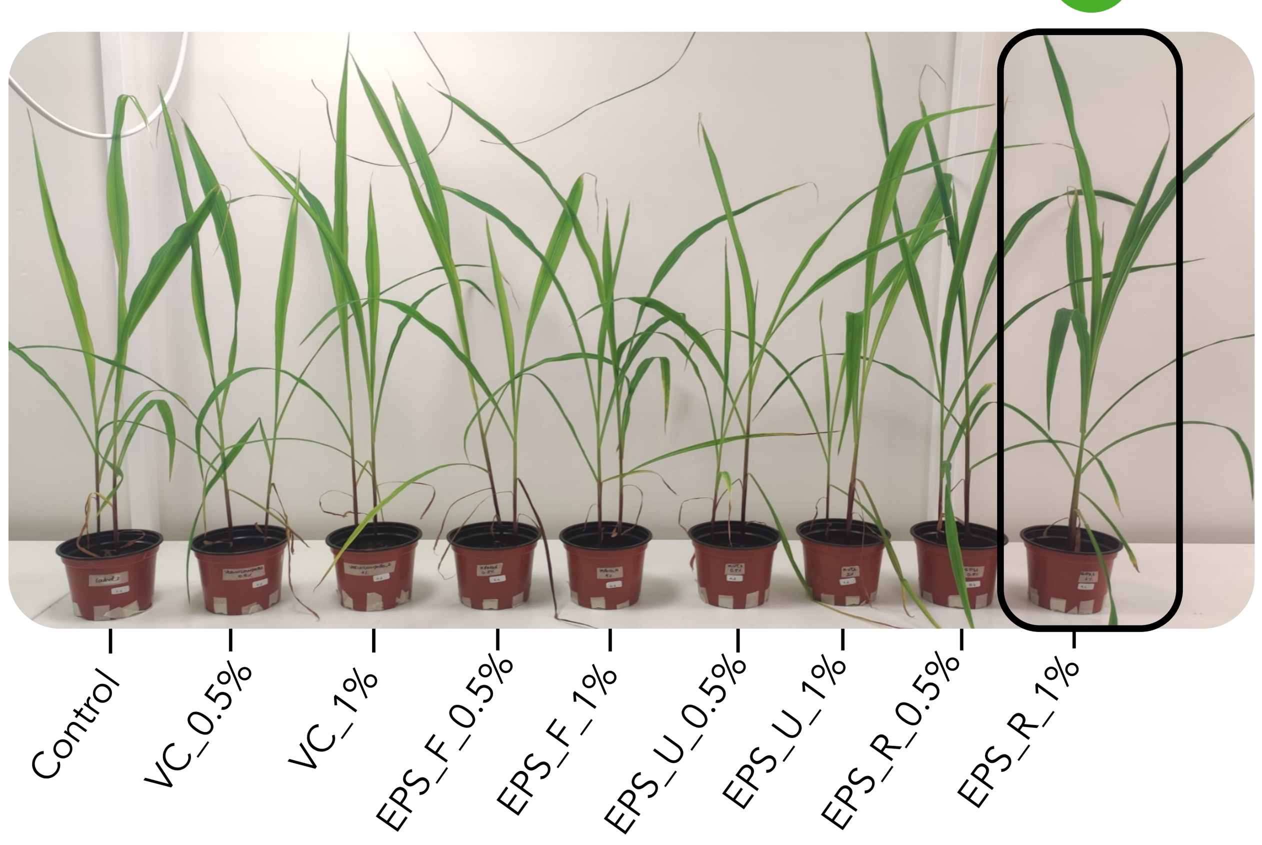


After 7 weeks

- **Maize growth**
- **Chlorophyll content**
- **Nutrient uptake**

RESULTS & DISCUSSION

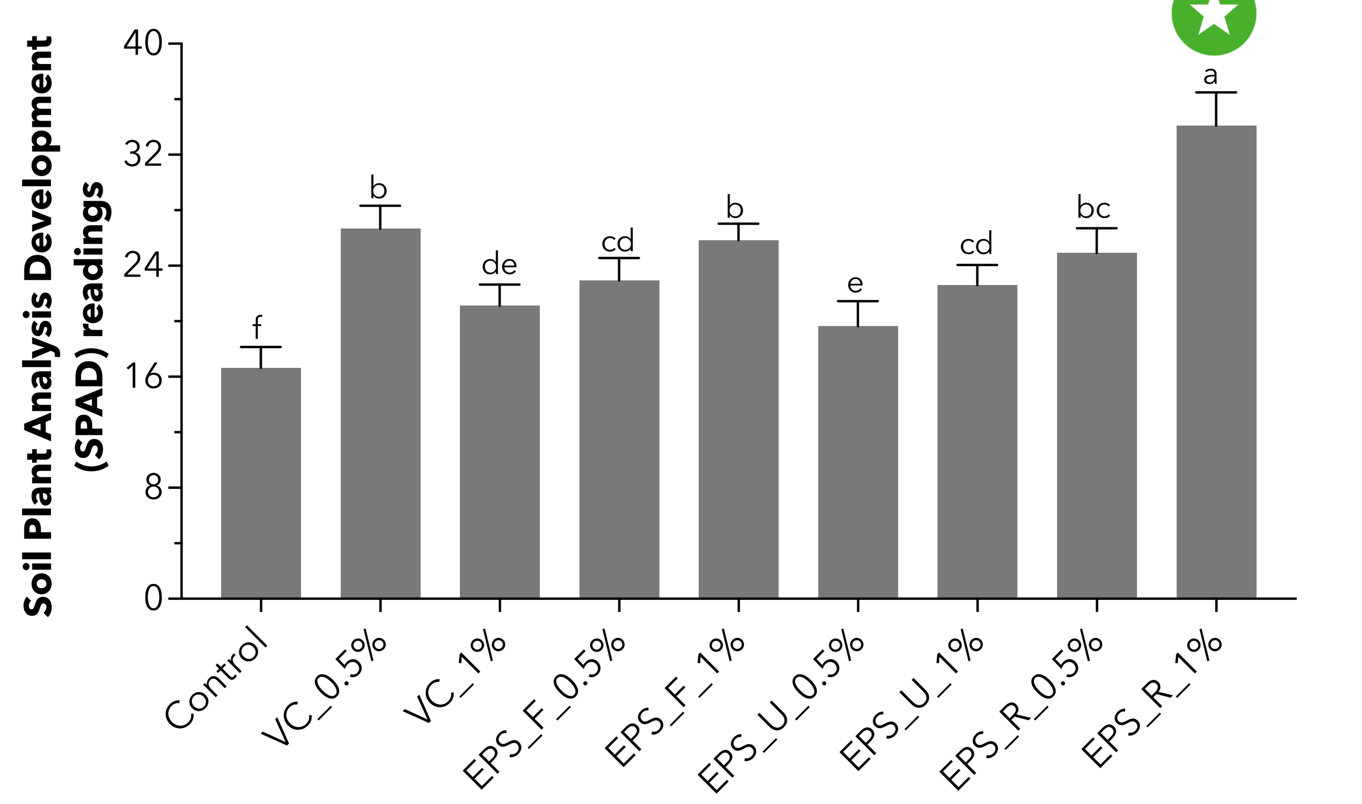
Maize growth



Plant growth-promoting effect of EPS_R

- Fresh shoot weight
- Stem thickness

Leaf chlorophyll content



- **1% of EPS**, regardless of the **source**, increased the **chlorophyll content**, especially pronounced in plants grown in soils with **1% of EPS_R**

Nutrient uptake

Nutrient content (mg/kg)

	Phosphorus (P)	Magnesium (Mg)	Potassium (K)	Sodium (Na)
Control	1424.61 ± 165.72^{ab}	2322.92 ± 230.36^{d}	30367.82 ± 2537.94^{bc}	60.01 ± 8.15^{a}
VC_0.5%	1479.56 ± 75.43^{ab}	2682.59 ± 215.13^{bcd}	30725.49 ± 995.13^{bc}	48.44 ± 5.91^{b}
VC_1%	1425.66 ± 127.52^{ab}	2400.44 ± 77.80^{d}	31236.24 ± 1154.57^{bc}	47.78 ± 7.98^{b}
EPS_F_0.5%	**1560.00 ± 212.63^{a}**	2440.07 ± 207.58^{d}	34314.41 ± 3288.45^{b}	37.05 ± 1.95^{c}
EPS_F_1%	**1659.91 ± 223.88^{a}**	3033.73 ± 370.62^{ab}	**40624.33 ± 3471.53^{a}**	**25.68 ± 3.13^{d}**
EPS_U_0.5%	**1615.29 ± 87.45^{a}**	2579.45 ± 23.49^{cd}	34748.64 ± 2494.71^{b}	40.03 ± 6.46^{c}
EPS_U_1%	1491.05 ± 111.84^{ab}	2380.48 ± 239.60^{d}	32027.67 ± 2390.55^{b}	**23.96 ± 2.68^{d}**
EPS_R_0.5%	**1519.97 ± 207.22^{a}**	2884.00 ± 295.22^{bc}	31757.78 ± 5008.98^{b}	**24.30 ± 2.92^{d}**
EPS_R_1%	1245.95 ± 152.08^{b}	**3383.78 ± 426.61^{a}**	27171.85 ± 1230.49^{c}	**20.20 ± 3.50^{d}**

- Maize grown in EPS-amended soils exhibited **higher P accumulation** in shoots
- EPS_R_1% and EPS_F_1% markedly **increased Mg** and **K** levels by 46% and 34%, respectively, compared to the control
- **EPS** and VC amendments **prevented Na translocation** to shoots, with the strongest effect in EPS amendments
- Certain EPS treatments **improved the use efficiency** of several **nutrients** (Na, K, Ca, and Zn), compared to the VC

CONCLUDING REMARKS

- Both the source and dose of EPS significantly influenced their effectiveness as soil amendments
- EPS outperformed the effects of vermicompost amendments, enhancing the photosynthetic efficiency and nutritional attributes of maize
- Using EPS as an agricultural product supports the circular economy in wastewater treatment and promotes sustainable practices in agriculture

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