Growth promotional traits of PGPR: possible uses for phytoremediation of degraded soils

Helena Moreira[1], Sofia I. Pereira[2], Alberto L. Veja[3], Paula M. L. Castro[4], Ana P. G. C. Marques[5]

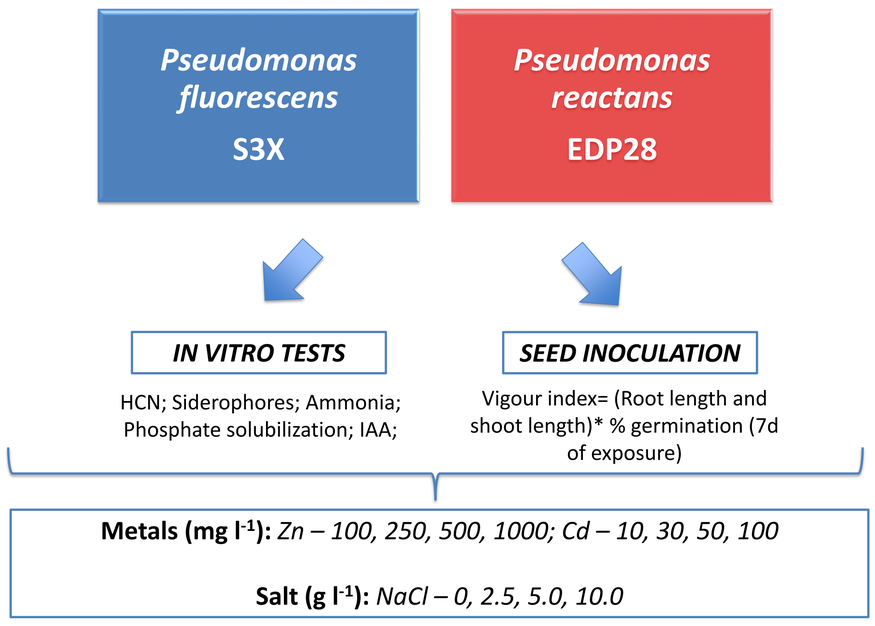
[1,2,3,4,5] CBQF – Centro de Biotecnologia e Química Fina, Escola Superior de Biotecnologia, Centro Regional do Porto da Universidade Católica Portuguesa, Rua D. António Bernardino de Almeida, 4200-072 Porto, Portugal
[1]hgmoreira@porto.ucp.pt, [2]sapereira@porto.ucp.pt, [3]alv07correo.ugr.es, [4]plcastro@porto.ucp.pt, [5]amarques@porto.ucp.pt

Scope and Aims

Plant Growth Promoting Bacteria (PGPR) play a key role in the establishment of plants in degraded areas, improving their health and growth through a variety of mechanisms:
i) antibiotic production, such as cyanide (HCN) which protects plants from diseases;
Iii) siderophores synthesis, which can solubilize unavailable metals and provide it to plants;
iii) phytohormones (e.g. IAA – indole acetic acid) synthesis, which can enhance plant growth;
iv) phosphorus solubilization, which makes it more readily available for the plant;
v) enzyme 1-aminocyclopropane – 1-carboxylate (ACC) deaminase production, which can lower plant ethylene levels by hydrolyzing ACC in ammonia and α-ketobutyrate and thereby provide some protection against the inhibitory effects of various stresses.
These bacteria can be used in remediation strategies helping plants to deal with environmental stresses, such as metal contamination and high salinization of soils. However, the growth-promoting traits present in PGPR may be disrupted or significantly decreased by metal and salt exposure.

The **aims of the present work** were to assess the influence of PGPR inoculation on seed vigour index of *Zea mays* and determine the growth promoting traits in medium supplemented with increasing concentrations of Zn, Cd and NaCl.

Methodology



Results/Discussion

Growth Promoting Traits of Selected Strains

HCN, NH_3, Siderophores, P solubilization

Table 1: In vitro screening for HCN, ammonia, siderophore production and P solubilization under exposure to increasing Zn, Cd and NaCl concentrations.

HCN												
		Cd				Zn				NaCl		
	0	10	30	50	100	100	250	500	1000	2.5	5	10
S3X	++	++	++	++	+	++	+	+	ND	+	+	+
EDP28	++	++	+	+	+	++	+	ND	ND	++	+	+
NH_3												
		Cd				Zn				NaCl		
	0	10	30	50	100	100	250	500	1000	2.5	5	10
S3X	++	++	++	++	++	++	++	+	+	+	+	+
EDP28	++	++	+	+	+	++	+	+	+	++	+	+
Siderophores												
		Cd				Zn				NaCl		
	0	10	30	50	100	100	250	500	1000	2.5	5	10
S3X	+	++	++	++	++	+	++	++	++	+++	+++	+++
EDP28	+	+++	+++	+++	++	+++	++	++	++	++	++	++
P solubilization												
		Cd				Zn				NaCl		
	0	10	30	50	100	100	250	500	1000	2.5	5	10
S3X	+	+	+	+	+	+	+	-	-	+	+	+
EDP28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

- Both bacteria showed HCN production at the two lowest Zn levels and at all tested Cd concentrations;
- Ammonia production was detected at all metal tested concentrations;
- Siderophores production was increased with increasing metal concentration exposure;
- Only S3X was able to solubilize phospate;
- Bacteria decreased ammonia production but increased siderophore release when exposed to increasing salt concentrations

Indole Acetic Acid (IAA) production

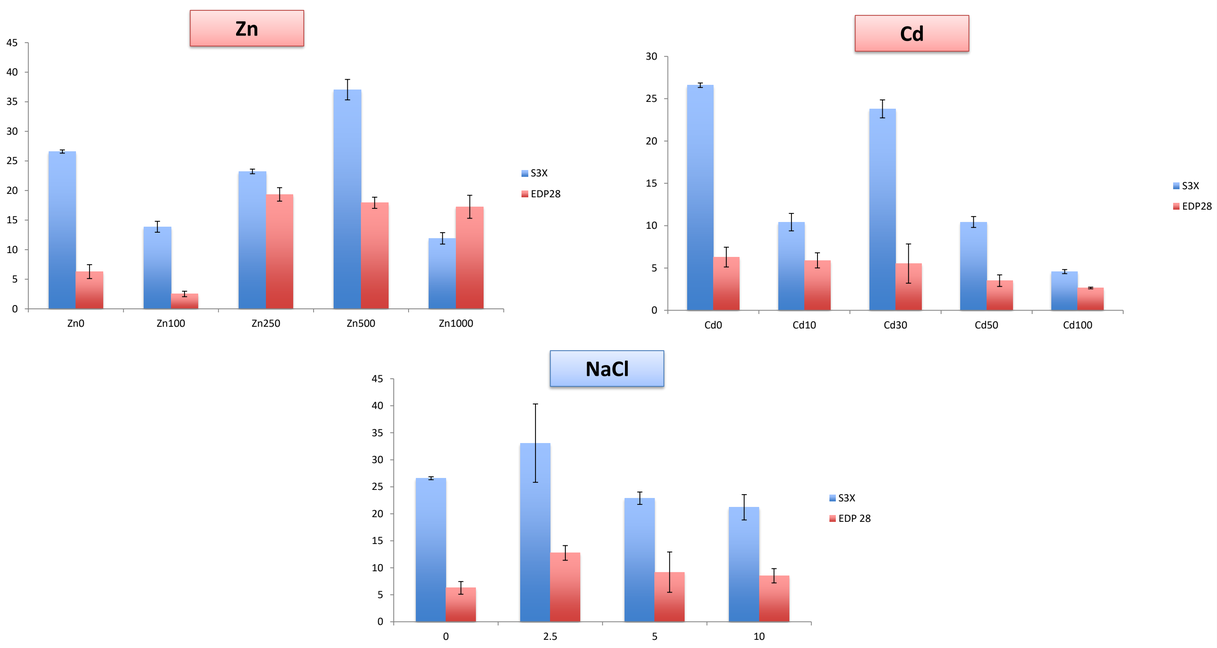


Figure 2: Indole acetic levels (IAA) (mg l^{-1}) of screened isolates exposed to Zn and Cd (mg l^{-1}) and NaCl (g) 72 h;. IAA was never detected in control cultures.

- IAA production by S3X was decreased with increasing Zn and Cd concentrations, except when exposed to 500 mg Zn l^{-1} ;
- Strain EDP28 showed high ability to produce IAA with increasing Zn concentrations and but when exposed to Cd highest concentrations, IAA production decreased;
- Metal exposure induced IAA higher levels production by strain EDP28.

Seed Vigour Index

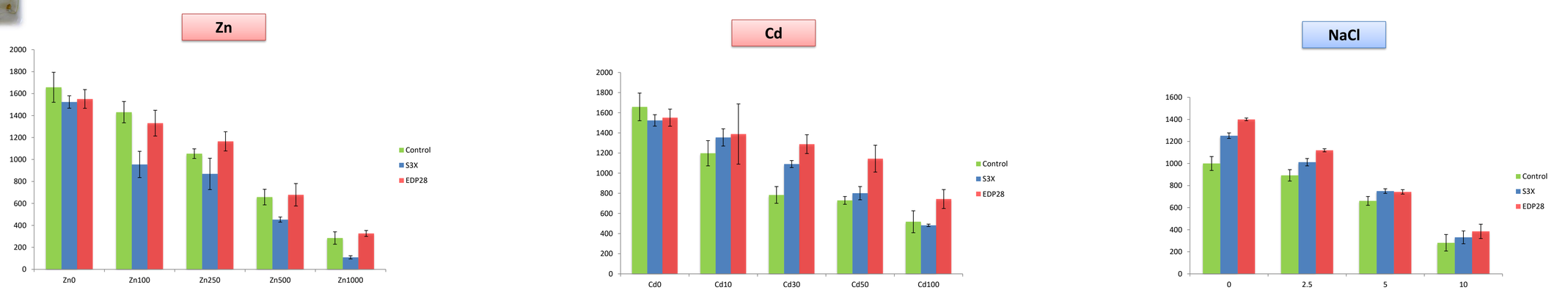


Figure 1: Vigour Index* (VI) of *Zea mays* plants exposed to Zn;, Cd (mg l^{-1}) and NaCl. Results are shown as means ±S.D (n=3).

- Increasing Zn and Cd concentrations negatively affected maize germination;
- VI was improved by EDP28 and S3X inoculation for all Cd increasing concentrations;
- EDP28 increased maize seed VI when exposed to Zn concentrations above 250 mg L^{-1};

- Increasing salt concentrations decreased maize germination;
- Both strains increased maize VI at all tested salt medium concentrations.

Conclusions

Metal type and concentration, as well as NaCl concentrations affect growth promoting traits of PGPR, and therefore the exhibition of growth-promoting traits in non-ammended medium may not be conclusive for further applications in degraded land. In vitro testing at the target levels of exposure as well as in vivo studies with the desired plants are necessary prior to drawing a PGPR-aided remediation strategies.

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