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Zinc alleviates copper toxicity to symbiotic nitrogen fixation in agricultural soil affected by copper mining in central Chile

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## ACCEPTED MANUSCRIPT

1	Zinc alleviates copper toxicity to symbiotic nitrogen fixation in agricultural soil affected by
2	copper mining in central Chile
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12	
13	Abstract
14	According to the Terrestrial Biotic Ligand Model, other cations might compete with Cu <sup>+2</sup> for biotic
15	ligand sites and provide a protective effect. In particular, evidence suggests Zn may alleviative Cu

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u toxicity. No study, to the best of our knowledge, has focused explicitly on the alleviating effect Zn might have on Cu toxicity to soil microorganisms in field-contaminated soils. The aim of this study was to investigate the alleviating effect Zn might have on Cu toxicity to symbiotic nitrogen fixation in agricultural soils affected by copper mining in central Chile. The bioassay estimated the symbiotic nitrogen fixation capacity of a population of rhizobia in a specified soil, using the soil as inocula for Phaseolus vulgaris L. grown in a soil-less system (pots with perlite) irrigated with a sterile nitrogenfree nutrient solution. Among all soil physicochemical characteristics, the Cu/Zn ratio best explained changes in symbiotic nitrogen fixation. The effective concentration 50% (EC<sub>50</sub>) of Cu/Zn ratio for symbiotic nitrogen was equal to 1.2, with 95% confidence interval of 1.0-1.3. Symbiotic nitrogen

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