Caffeic acid affects the bioaccumulation of copper into maize plant

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INTRODUCTION

Phenolic acids are secondary metabolites that form a diverse group of ubiquitously distributed hydroxybenzoic and hydroxycinnamic acids in plants. They have been widely implicated in negative plant-plant interactions including allelopathy. They constitute an important class of allelochemicals that release into the soil from plants through various mechanisms such as root exudation, leaching, and residue decomposition. Upon release, they play a multitude of ecological and physiological roles. For example, they inhibit plant growth, alter mineral uptake, disrupt membrane permeability, cause stomatal closure and induce water stress, affect photosynthesis and protein synthesis and alter enzyme activities.

Caffeic acid is one of the most common cinnamic acids ubiquitously present in plants and implicated in a variety of interactions including allelopathy among plants and microbes. This study evaluates the influence of caffeic acid in the growth and development of maize plant under copper stress conditions and also the changes on metal bioaccumulation to the different parts of the plant.

EXPERIMENTAL

The effect of CA (1, 10, 50 and 100 µM) in a copper contaminated medium (2.5; 25µg/mL) on early growth of maize and metal bioaccumulation were studied under laboratory conditions in a Petri dish bioassay (five Petri dishes per treatment and 10 seeds each). Maize seeds imbibed in the respective solution of CA and copper or distilled water (as control) for 16h were placed equidistantly on filter paper moistened with 10mL of respective treatment solution in a 15cm diameter Petri dish. These were maintained in a completely randomized manner in an environmentally controlled growth chamber maintained at 25°C temperature. After 7 day plantlet length and seedling dry weight were determined.

Maize plantlet dry samples (separated into rootlets, hypocotyls and cotyledons) were mineralized in 10 mL HNO3 (85%) and 2mLH2O2 (30%) on a hot plate (120°C) for at least 5h and then the copper concentration was determined using a GBC Avanta Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The presence of caffeic acid into the growth medium present no stimulatory effects on maize plant elongation comparing with control. In stead it could be observed that inhibitory effects of heavy metal-2.5µg/mL Cu(II) on plantlet elongation was moderated in the presence of caffeic acid (1, 10µM) and in the case of 1, 50µM caffeic acid for 25 µg/mL copper contamination level. The other concentrations of caffeic acid in the medium accentuated the metal inhibitory effects on plantlet elongation.

Bioaccumulation of copper ions into maize plant decreased also with increasing heavy metal concentration into the medium. Copper ions were predominantly accumulated into the rootlets part of maize plantlet. A relative stimulatory effect of 9-10% was observed in the presence of caffeic acid (1, 100µM) on copper bioaccumulation under 2.5µg/mL Cu (II) contamination. When the copper concentration was much higher into the growth medium, a stimulatory effect (18-20%) on bioaccumulation was registered in the presence of 50, 100µM caffeic acid.

CONCLUSIONS

- The presence of caffeic acid solutions in the growth medium promoted the growth and development of maize plantlet in copper stress conditions.
- Caffeic acids in 1 and 100µM concentration into the medium stimulated the bioaccumulation of copper ions into maize plantlet for both metal contamination level.
- The addition of caffeic acids in 2.5µg/mL Cu (II) stress conditions reduced the transport of the metal to the aerial parts of the maize plantlet, instead promoted the translocation with increasing copper contamination level.