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外源铅、铜胁迫对不同基因型谷子幼苗生理生态特性的影响

Effects of exogenous pb and cu stress on eco-physiological characteristics on foxtail millet seedlings of different genotypes

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中文摘要:

采用盆栽土培法,研究了4种基因型谷子幼苗对Pb²⁺、Cu²⁺胁迫的生长响应、DNA损伤及吸收积累、迁移特性。结果表明,D2-8、安06、黄米和朝谷幼苗对Pb²⁺、Cu²⁺的平均耐性指数分别为0.87、0.81、0.78、0.71和0.96、0.97、0.79、0.74。在400 mg/kg Pb²⁺、Cu²⁺浓度下,4种谷子幼苗叶绿素a、b总量分别为对照的33.3%、52.6%、37.5%、49.4%和113.5%、72.3%、51.9%、75.6%,而叶绿素a/b值均高于对照。Pb²⁺胁迫下4种谷子幼苗中可溶性蛋白质和DNA含量随浓度升高逐渐下降,Cu²⁺处理组则表现为低浓度(≤100 mg/kg)的促进和高浓度(≥200 mg/kg)的抑制效应。4种谷子幼苗的DNA增色效应值在Pb²⁺、Cu²⁺胁迫下均表现为先上升后下降的趋势,其中Pb²⁺对朝谷和D2-8的增色效应影响较大,而Cu²⁺对朝谷和安06的影响最为明显。D2-8和朝谷对Pb²⁺、Cu²⁺的吸收富集能力高于安06和黄米,D2-8和安06对Pb²⁺、Cu²⁺的转运能力大于朝谷和黄米。总体来看,Pb²⁺对谷子幼苗的生理生态影响和遗传毒害效应大于Cu²⁺,4种基因型谷子对Pb²⁺胁迫的耐性顺序为安06>D2-8>黄米>朝谷,对Cu²⁺的耐性顺序为D2-8>安06>朝谷>黄米。

English Summary:

The ions of Pb²⁺, Cu²⁺ are two important environmental pollutants. Pb²⁺ is without biological functions but, once entering into the field, reduces the fertility, inhibits crops root growth, hinders physiological metabolism, damages the nucleolar structure and reduced the fidelity of DNA synthesis. Cu²⁺ is essential element; however, large Cu²⁺ accumulation in crops causes genotoxicity or even crop mortality. This study examined the growth, DNA damage, uptake and accumulation of Pb²⁺ and Cu²⁺ among four genotypes of foxtail millet (*Setaria italica*(L.)Beauv) seedlings from Shanxi, China using a pot culturing. The foxtail millet seeds were cultured in incubators at 26 °C for germination with no light, then planted in the pots spiked with four different concentration, namely 50, 100, 200, 400(mg/kg of each kind of metal ions), respectively. The growth of roots and shoots, biomass, chlorophyll content, soluble protein content, DNA content, DNA hyperchromicity and the uptake and accumulation were studied after a growing period of 30 days. The result showed that the average of Pb²⁺ tolerance indexes of D2-8, An 06, Huangmi, Zhaogu were 0.87, 0.81, 0.78 and 0.71, while those of Cu²⁺ were 0.96, 0.97, 0.79 and 0.74 respectively. In the photosynthetic pigment test, the total content of chlorophyll a and b of D2-8, An 06, Huangmi, Zhaogu exposed to 400 mg/kg Pb²⁺ were 33.3%, 52.6%, 37.5%, 49.4% as compared with the control group; while those were 113.5%, 72.3%, 51.9%, 75.6% as compared with control in Cu²⁺ (400 mg/kg) treatment. And the chlorophyll a/b values in foxtail millet of four genotypes were all higher than that of the control group. The content of DNA and the soluble protein decreased with the increasing of Pb²⁺ concentration, showing Cu²⁺ stimulated the DNA and soluble protein synthesis at low concentrations (less than 100 mg/kg), but inhibited at high concentrations (more than 200 mg/kg), respectively. DNA hyperchromicity indicates the disruption of the DNA primary structure, with the trend of initial increased followed by decline in all four foxtail millet seedlings in response to the rising Pb²⁺ and Cu²⁺ concentrations. In addition, the DNA hyperchromicity of Zhaogu and D2-8 were significantly affected by Pb²⁺, so were Zhaogu and Huangmi affected by Cu²⁺. The uptake and accumulation of Pb²⁺ or Cu²⁺ ranks (from high to low): D2-8, zhaogu, An 06, Huangmi. The transportation ability of D2-8 and An 06 from roots to stems and leaves was much better than that of Zhaogu and Huangmi. From the effects on the growth indexes and physiological indices, it was found that the ecophysiological- and geno-toxicities of Pb²⁺ on foxtail millet seedlings was higher than Cu²⁺. The tolerance order of Pb²⁺ was An 06>D2-8>Huangmi>Zhaogu, and the tolerance of Cu²⁺ was D2-8> An 06> Zhaogu >Huangmi.

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