

缺锌胁迫对苹果砧木幼苗形态及其锌积累的影响

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Effects of Zinc Deficiency Stress on the Root Architecture and Zinc Accumulation of the Different Apple Rootstocks

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摘要 在人工气候室条件下, 采用溶液培养法研究了缺锌胁迫下平邑甜茶 (*Malus hupehensis* Rehd.) 和小金海棠 (*Malus xiaojinensis* Cheng et Jiang) 两种苹果砧木幼苗生长量、根系构型参数、根系活力和锌积累量的动态变化。结果表明: 缺锌条件下, 两品种均表现不同程度的植株矮小, 新生叶片黄化且簇生, 节间缩短, 根尖膨大等缺锌症状, 小金海棠表现缺锌症状比平邑甜茶延迟7 d 左右。长期锌缺乏使平邑甜茶根系生物量显著降低。两品种缺锌植株根系长度、表面积、体积、根尖数从21 d 开始均低于对照; 60 d时平邑甜茶较对照分别下降45.47%、44.2%、47.18%、43.14%, 小金海棠分别降低38.95%、31.90%、32.58%、35.52%, 平邑甜茶被抑制程度大于小金海棠。根系平均直径处理大于对照, 且小金海棠表现根系膨大症状较平邑甜茶晚10 d。缺锌条件下小金海棠根系活力达最大比平邑甜茶晚15 d。处理和对照幼苗锌含量均表现为根系 > 茎 > 叶片, 且小金海棠处理植株 > 平邑甜茶处理植株。平邑甜茶对缺锌胁迫较敏感, 根系易受到伤害; 小金海棠在缺锌胁迫下锌含量下降速率慢, 对缺锌胁迫有较强的抵御和耐受能力。

关键词: [平邑甜茶](#) [小金海棠](#) [砧木](#) [缺锌胁迫](#) [根构型](#) [锌积累](#)

Abstract: The physiological and root morphology responses of two apple rootstocks under zinc deficiency stress were investigated for exploring the difference of endurance and sensitivity to zinc-deficiency stress between cultivars of two apple rootstocks. The experiment was carried out with the seedlings of two apple rootstocks cultivars (*Malus hupehensis* Rehd. and *Malus xiaojinensis* Cheng et Jiang) under zinc-deficiency stress with hydroponics. The changes in the biomass, the morphology and architecture of root, the activity of root, and the zinc accumulation in plant shoot and root were studied. There were significant differences between different apple rootstocks cultivars in response to zinc-deficiency stress. The obtained results showed that many obvious zinc-deficiency symptoms were observed in the two apple rootstocks seedling receiving no Zn supply, such as, the plant dwarfed, the new leaves etiolated and rosetted, the length of stem node decreased and the root tips enlarged. The results also indicated that zinc-deficiency treatment delayed the occurrence of zinc-deficiency symptoms of the *Malus xiaojinensis* Cheng et Jiang seedling by 7 days than the *Malus hupehensis* Rehd. The biomass of *Malus hupehensis* Rehd. root system was significantly inhibited under zinc-deficiency stress. Root is more sensitive to zinc deficiency than that of shoot. Cultured for 20 days in a zinc-deficiency solution, the root length, root surface area, root volume and the number of root tips of the two apple rootstocks cultivars are both decreased seriously, and the decreased ranges of *Malus xiaojinensis* Cheng et Jiang are smaller than those of *Malus hupehensis* Rehd., contrarily, the average diameter of two cultivars roots are increased under zinc-deficiency condition. *Malus hupehensis* Rehd. treatment plant had the maximum value of root activity of *Malus hupehensis* Rehd. treatment plant appeared at the 30th day, while that of *Malus xiaojinensis* Cheng et Jiang appeared at 45th day. The content of Zn of two cultivars under zinc-deficiency stress was in the order as below: Root > stem > leaf. Control plants > *Malus xiaojinensis* Cheng et Jiang > *Malus hupehensis* Rehd. treatment plant. The sensitivity and endurance of the two apple rootstocks seedlings to zinc-deficiency stress were different. The *Malus hupehensis* Rehd. was more sensitive to zinc deficiency and its root was vulnerable to zinc-deficiency stress, while *Malus xiaojinensis* Cheng et Jiang presented less decrease in its zinc content and had better endurance and resistance to the zinc-deficiency stress.

Keywords: [Malus hupehensis](#), [Malus xiaojinensis](#), [rootstock](#), [zinc-deficiency stress](#), [root system architecture](#), [zinc accumulation](#)

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