

论文

胺鲜酯和镉对蓖麻幼苗光合生理特性的影响

张铮, 钱宝云, 程晓庆, 刘彩凤, 史刚荣

资源植物学安徽省重点实验室, 淮北师范大学生命科学院, 安徽 淮北 235000

摘要:

以蓖麻(Ricinus communis L.)为研究对象,通过水培试验研究胺鲜酯(DA-6)和镉(Cd)对蓖麻生长和光合生理特性的交互作用,探讨DA-6浸种对植物Cd毒害是否具有缓解作用。研究表明,50μmol·L⁻¹CdCl₂对蓖麻幼苗生长和光合作用具有抑制作用。Cd处理显著降低蓖麻叶片的光合速率(Pn)、气孔导度(Gs)和蒸腾速率(E),而胞间CO₂浓度(Ci)则明显增大;在Cd胁迫下,蓖麻叶片的叶绿素a、b、a+b、类胡萝卜素含量以及叶绿素/类胡萝卜素比值均显著降低,而叶绿素a/b比值则显著增大;Cd胁迫导致F₀增大,F_m、F_v/F_m、F_v/F₀和ΦPS II显著降低。无论是否添加Cd,DA-6对蓖麻幼苗的生长均没有显著影响;同时,DA-6处理对蓖麻幼苗的镉积累也没有显著影响。在正常情况下,DA-6处理能提高蓖麻叶片的光合色素含量,但叶绿素a/b比值、叶绿素/类胡萝卜素比值以及叶绿素荧光参数和气体交换参数均没有显著影响。在Cd胁迫下,10和1000mg·L⁻¹ DA-6处理不仅导致光合色素含量(Chl a、Chl b、Chl a+b和Car)和气体交换参数(Pn、E和Gs)降低,同时也导致F_m、F_v/F_m、F_v/F₀和ΦPS II降低。可见DA-6不仅不能缓解Cd对蓖麻幼苗的毒害,而且通过降低光合色素含量和PS II的光化学活性,加重了Cd对光合作用的抑制作用。

关键词: 镉 胺鲜酯 蓖麻 光合作用

RESPONSES OF PHOTOSYNTHETIC TRAITS OF CASTOR BEAN SEEDLINGS TO CADMIUM AND DIETHYL AMINOETHYL HEXANOATE

ZHANG Zheng, QIAN Bao-yun, CHEN Xiao-qing, LIU Cai-feng, SHI Gang-rong

The Anhui Provincial Key Laboratory of the Resource Plant Biology, College of Life Sciences, Huaibei Normal University, Huaibei, Anhui 235000

Abstract:

To determine whether diethyl aminoethyl hexanoate (DA-6) pretreatment alleviated the cadmium (Cd) toxicity to castor bean (*Ricinus communis* L.) seedlings, effects of Cd (0, 50μmol·L⁻¹CdCl₂) and DA-6 (0, 0.1, 10 and 1000mg·L⁻¹), and their interactions on plant growth and photosynthesis were investigated. Results showed that 50 μmol·L⁻¹CdCl₂ inhibited plant growth and photosynthesis of castor seedlings. Under Cd exposure, the net photosynthetic rate (Pn), stomatal conductance (Gs) and transpiration rate (E), photosynthetic pigment contents (Chl a, Chl b, Chl a+b, Car and Chl /Car) and chlorophyll fluorescence parameters (F_m, F_v/F_m, F_v/F₀and ΦPS II) decreased, whereas the intercellular CO₂ concentration (Ci), Chl a/b and F₀ increased. Presoaking seeds with different concentrations of DA-6 did not change the plant growth regardless of Cd. In the absence of Cd, DA-6 pretreatment significantly enhanced the pigment contents (Chl a, Chl b, Chl a+b and Car) in castor leaves, while the ratio of pigment content (Chl a/b, Chl/Car), chlorophyll fluorescence parameters, and gas exchange parameters remained unaffected. In the present of Cd, presoaking seeds with 10 and 1000mg·L⁻¹ DA-6 caused a reduction in pigment contents (Chl a, Chl b, Chl a+b and Car), gas exchange parameters (Pn, E and Gs), as well as chlorophyll fluorescence parameters (F_m, F_v/F_m, F_v/F₀and ΦPS II) in castor seedlings. It was indicated that DA-6 presoaking might aggravate, rather than alleviate, the inhibition of Cd on photosynthesis of castor bean seedlings.

Keywords: cadmium diethyl aminoethyl hexanoate castor bean photosynthesis

收稿日期 2010-08-04 修回日期 2010-10-12 网络版发布日期

DOI:

基金项目:

安徽省自然科学基金(11040606M87)

通讯作者: 史刚荣(1968-),男,甘肃陇西人,教授,博士,研究方向为植物生理生态学。Tel: 0561-3802493;E-mail: swsgr@126.com

扩展功能

本文信息

- ▶ Supporting info
- ▶ PDF(321KB)
- ▶ [HTML全文]
- ▶ 参考文献[PDF]
- ▶ 参考文献

服务与反馈

- ▶ 把本文推荐给朋友
- ▶ 加入我的书架
- ▶ 加入引用管理器
- ▶ 引用本文
- ▶ Email Alert
- ▶ 文章反馈
- ▶ 浏览反馈信息

本文关键词相关文章

- ▶ 镉
- ▶ 胺鲜酯
- ▶ 蓖麻
- ▶ 光合作用

本文作者相关文章

- ▶ 张铮
- ▶ 钱宝云
- ▶ 程晓庆
- ▶ 刘彩凤
- ▶ 史刚荣

PubMed

- ▶ Article by Zhang, Z.
- ▶ Article by Qian, B. Y.
- ▶ Article by Cheng, X. Q.
- ▶ Article by Liu, C. F.
- ▶ Article by Shi, G. R.

参考文献:

- [1] 黄益宗, 朱永官. 森林生态系统镉污染研究进展
[J]. 生态学报, 2004, 24(1): 101-108
- [2] Di Toppi L S, Gabbriellini R. Response to cadmium in higher plants
[J]. Environ Exp Bot, 1999, 41(2): 105-130
- [3] Das P, Samantaray S, Rout G R. Studies on cadmium toxicity in plants: a review
[J]. Environ Pollut, 1997, 98(1): 29-36
- [4] Boussama N, Ouariti O, Suzuki A, Ghorbal M H. Cd-stress on nitrogen assimilation
[J]. J Plant Physiol, 1999, 155(3): 310-317
- [5] Barcelo J, Poschenrieder C. Plant water relations as affected by heavy metal stress: a review
[J]. J Plant Nutr, 1990, 13(1): 1-37
- [6] Horváth G, Droppa M, Oraveczá, Raskin V I, Marder J B. Formation of the photosynthetic apparatus during greening of cadmium-poisoned barley leaves
[J]. Planta, 1996, 199(2): 238-243
- [7] Benavides M, Gallego M S, Tomaro M L. Cadmium toxicity in plants
[J]. Braz J Plant Physiol, 2005, 17(1): 21-34
- [8] 顾万荣, 李召虎, 翟志席, 段留生, 张明才. DCPTA 和 DTA-6 对拟南芥种子萌发和根系生长发育的影响
[J]. 中国农学通报, 2008, 24(6): 37-43
- [9] 苗鹏飞, 刘国杰, 李绍华, 单守明. DA-6 对秋季草莓叶片光合速率和植株生长的影响
[J]. 应用生态学报, 2007, 18(12): 2722-2726
- [10] 于俊红, 彭智平, 杨少海, 黄继川, 詹愈忠. DA-6 对干旱胁迫下花生生理及生长指标的影响
[J]. 干旱地区农业研究, 2009, 27(1): 168-172
- [11] 周天, 胡永军, 周晓梅, 王萍, 郭继勋. DA-6 对野大麦幼苗光合作用和生长的影响
[J]. 草业科学, 2004, 21(4): 31-34
- [12] 单守明, 刘国杰, 李绍华, 苗鹏飞. DA-6 对草莓叶绿体光化学反应和 Rubisco 活性的影响
[J]. 中国农业大学学报, 2008, 13(2): 7-10
- [13] 郑殿峰, 赵黎明, 冯乃杰. 植物生长调节剂对大豆叶片内源激素含量及保护酶活性的影响
[J]. 作物学报, 2008, 34(7): 1233-1239
- [14] 刘祥英, 柏连阳. DA-6 缓解胺苯磺隆对后茬水稻伤害的作用
[J]. 现代农药, 2005, 4(3): 31-32
- [15] 施晓明, 李淑芹, 许景钢, 佟玉欣. 干旱胁迫下 DA-6 浸种对大豆苗期叶片保护酶活性的影响
[J]. 东北农业大学学报, 2009, 40(9): 48-51
- [16] 梁颖. DA-6 对水稻幼苗抗冷性的影响
[J]. 山地农业生物学报, 2003, 22(2): 95-98
- [17] 邵 玲, 梁广坚, 蔡惠丽. 喷施己酸二乙氨基乙醇酯对几种与番茄幼苗抗冷性相关生理指标的影响
[J]. 植物生理学通讯, 2007, 43(6): 1105-1108
- [18] Shi G, Cai Q. Cadmium tolerance and accumulation in eight potential energy crops
[J]. Biotechnol Adv, 2009, 27(5): 555-561
- [19] Shi G, Cai Q. Zinc tolerance and accumulation in eight oil crops
[J]. J Plant Nutr, 2010, 33(7): 982-997

- [20] Demmig B, Winter K, Krueger A, Czygan F C. Photoinhibition and zeaxanthin formation in intact leaves. A possible role of the xanthophyll cycle in the dissipation of excess light energy [J]. *Plant Physiol*, 1987, 84(1): 218-224
- [21] Gilmore A M, Yamamoto H Y. Zeaxanthin formation and energy-dependent fluorescence quenching in pea chloroplasts under artificially mediated linear and cyclic electron transport [J]. *Plant Physiol*, 1991, 96(2): 635-643
- [22] Krause G H, Weis E. Chlorophyll fluorescence and photosynthesis: the basics [J]. *Annu Rev Plant Physiol Plant Mol Biol*, 1991, 42: 313-349
- [23] 孙宪芝, 郑成淑, 王秀峰. 高温胁迫对切花菊‘神马’光合作用与叶绿素荧光的影响 [J]. *应用生态学报*, 2008, 19(10): 2149-2154
- [24] Shi G, Cai Q, Liu Q, Wu L. Salicylic acid-mediated alleviation of cadmium toxicity in hemp plants in relation to cadmium uptake, photosynthesis, and antioxidant enzymes [J]. *Acta Physiol Plant*, 2009, 31(5): 969-977
- [25] Ekmeki Y, Tanyolad, Ayhan B. Effects of cadmium on antioxidant enzyme and photosynthetic activities in leaves of two maize cultivars [J]. *J Plant Physiol*, 2008, 165(6): 600-611
- [26] Mediavilla S, Santiago H, Escudero A. Stomatal and mesophyll limitations to photosynthesis in one evergreen and one deciduous Mediterranean oak species [J]. *Photosynthetica*, 2002, 40(4): 553-559
- [27] Farquhar G D, Sharkey T D. Stomatal conductance and photosynthesis [J]. *Annu Rev Plant Physiol*, 1982, 33(1): 317-345
- [28] Chartzoulakis K, Patakas A, Kofidis G, Bosabalidis A, Nastou A. Water stress affects leaf anatomy, gas exchange, water relations and growth of two avocado cultivars [J]. *Sci Hortic*, 2002, 95(1-2): 39-50
- [29] Mobin M, Khan N A. Photosynthetic activity, pigment composition and antioxidative response of two mustard (*Brassica juncea*) cultivars differing in photosynthetic capacity subjected to cadmium stress [J]. *J Plant Physiol*, 2007, 164(5): 601-610
- [30] Singh A K, Dubey R S. Changes in chlorophyll a and b contents and activities of photosystems 1 and 2 in rice seedlings induced by NaCl [J]. *Photosynthetica*, 1995, 31: 489-499
- [31] Behera R K, Mishra P C, Choudhury N K. High irradiance and water stress induce alterations in pigment composition and chloroplast activities of primary wheat leaves [J]. *J Plant Physiol*, 2002, 159(9): 967-973
- [32] Roháček K. Chlorophyll fluorescence parameters: the definitions, photosynthetic meaning, and mutual relationships [J]. *Photosynthetica*, 2002, 40(1): 13-29
- [33] 杨晓青, 张岁岐, 梁宗锁, 山颖. 水分胁迫对不同抗旱类型冬小麦幼苗叶绿素荧光参数的影响 [J]. *西北植物学报*, 2004, 24(5): 812-816
- [34] Shi G, Liu C, Cai Q, Liu Q, Hou C. Cadmium accumulation and tolerance of two safflower cultivars in relation to photosynthesis and antioxidative enzymes [J]. *Bull Environ Contam Toxicol*, 2010, 85(3): 256-263

本刊中的类似文章

1. 刘俊祥, 孙振元, 巨关升, 韩蕾, 钱永强. 重金属 Cd^{2+} 对结缕草叶片光合特性的影响[J]. *核农学报*, 2009, 23(6): 1050-1053
2. 陈建明, 俞晓平, 陈俊伟, 吕仲贤, 程家安, 陶林勇, 郑许松, 徐红星. 水稻植株光合作用能力的变化与其抗白背飞虱的关系[J]. *核农学报*, 2003, 17(06): 423-426+416
3. 李英, 喻景权. CPPU处理瓠瓜子房对叶片光合作用和 $- (14)C$ -同化物分配的影响[J]. *核农学报*, 2001, 15(06): 355-359
4. 王志芬, 宋良增, 范仲学, 张风云, 刘益同, 王守瑰, 朱连先, 朱伯良, 徐明振, 高华强, 王周文. 越冬期间小麦的光合作用及其对生长发育的影响[J]. *核农学报*, 2001, 15(04): 243-246

5. 吴启堂, J.L. Morel, A. Guckert. 用同位素稀释法研究土壤-植物系统镉的迁移[J]. 核农学报, 1993, 7(02): 110-116
6. 巫建华, 龚荐, 罗时石. 小麦根系物质流示踪研究[J]. 核农学报, 1992, 6(03): 147-152
7. 史跃林, 孙业芝, 许贵民, 蔡启运. 温度对黄瓜光合作用及 ^{14}C -同化物运转分配的影响[J]. 核农学报, 1991, 5(04): 219-223
8. 陈因, 方大惟. 蓝藻 *Anabaena* 7120 固氮酶活性表达和生理条件的关系[J]. 核农学报, 1990, 4(02): 93-98
9. 冯春生; 沈银保; 杜志中; 高金方; 赵福林; 赵述文; 徐豹; . FGC-2型 ^{14}C 植物光合速率测量装置[J]. 核农学报, 1987, 1(04): 105-111
10. 王应军, 邓仕槐, 姜静, 尚鹤, 林波, 孙亚琴, 胡晓梅. 酸雨对木芙蓉幼苗光合作用及抗氧化酶活性的影响[J]. 核农学报, 2011, 25(3): 588-593, 581
11. 孟华兵 杜雪 姜宇晓 朴学成 郭万里 蒋立希. 镉胁迫下二倍体和同源四倍体油菜DNA甲基化差异分析[J]. 核农学报, 2010, 24(6): 1297-1304
12. 朱雪云, 王燕, 陈利萍. 榨菜 (*Brassica juncea*) 和紫甘蓝 (*Brassica oleracea*) 种间周缘嵌合体光合特性研究[J]. 核农学报, 2010, 24(2): 401-406
13. 孙胜, 张智, 卢敏敏, 邢国明. Cd^{2+} 胁迫对西瓜幼苗光合生理及活性氧代谢的影响[J]. 核农学报, 2010, 24(2): 389-393
14. 徐向东, 孙艳, 郭晓芹, 孙波, 张坚. 高温胁迫下外源褪黑素对黄瓜幼苗光合作用及叶绿素荧光的影响[J]. 核农学报, 2011, 25(1): 179-184
15. 郝兴宇, 李萍, 林而达, 全乘风, 魏强, 巫国栋, 董小刚. 大气 CO_2 浓度升高对谷子生长发育与光合生理的影响[J]. 核农学报, 2010, 24(3): 589-593