

钙对酸雨胁迫下甜瓜幼苗质膜透性的影响*

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摘要 报道钙对酸雨胁迫下甜瓜幼苗质膜透性的影响. 实验结果表明, 钙可明显降低质膜透性, 具有防护质膜酸致损伤的良好作用. 在本实验条件下, 以30mmol/L $\text{Ca}(\text{NO}_3)_2$ 连续处理2次(24h 1次)的防护作用最佳. 可能与钙能稳定质膜结构, 提高CAT活力等多重生理作用有关.

关键词 钙, 质膜透性, 酸雨胁迫, 甜瓜幼苗.

钙在生理学上有防止膜损伤和渗漏、稳定膜结构和维持膜的完整性等多重作用^[1]. 电镜观察证实, 缺钙导致细胞膜解体, 加钙又恢复到常态^[2]. 有关钙在干旱、盐渍、低温等逆境胁迫下对细胞膜稳定性的影响已有大量研究^[3, 4], 唯对酸雨胁迫下钙与质膜透性关系方面报道甚少. 本文以甜瓜幼苗为试材, 探讨了钙对酸雨胁迫下质膜透性的影响及其内在成因, 旨在为化学调控植物代谢、增强生理系统功能, 强化植物抵御酸雨胁迫能力提供参考.

1 材料与方法

1.1 实验材料培养

甜瓜(*Cucumis melo*) 品种: 华莱士, 种子经0.1%升汞消毒, 蒸馏水中萌发后移至蛭石中. 以1/2浓度 Hoagland 营养液培养于温室中, 室内温度 $25 \pm 1^\circ\text{C}$ / $19 \pm 20^\circ\text{C}$, 光照5000lx. 幼苗长至第4枚真叶时进行实验. 每钵3株, 3次重复.

1.2 钙与酸雨处理方法

将分析纯 $\text{Ca}(\text{NO}_3)_2$ 配成10、30、50mmol/L 梯度溶液, 以医用喷雾器均匀喷洒甜瓜幼苗, 滴水为度; 模拟酸雨(以下简称酸雨) 按毕玉蓉等(1993) 方法配制^[5], 在钙处理后24h, 将加有数滴吐温-20、pH2.0的酸雨均匀喷洒于整株叶片, 使叶片完全浸润, 每24h 1次, 连喷2次后进行生理指标的测定. 对照植株喷洒等量蒸馏水(pH6.8).

1.3 生理学指标测定

叶片质膜透性以改良电导法测定^[6], 丙二

醛(MDA) 含量按陈贵等(1991) 方法测定^[7], 过氧化氢酶(CAT) 活力用氧电极法测定^[8], 所有测定数据均以3次重复之平均值表示.

2 实验结果

2.1 钙对质膜透性的影响

现已明确, 钙与质膜成分形成的复杂交联结合是稳定膜结构和维持膜完整性的重要因素^[1]. 不同浓度钙的处理结果表明, 随着钙浓度增加, 甜瓜幼苗叶片的质膜透性明显降低. 钙降低质膜透性的效应序列为 $30\text{mmol/L} > 50\text{mmol/L} > 10\text{mmol/L}$ $\text{Ca}(\text{NO}_3)_2$ (表1). 而当钙浓度 $\geq 50\text{mmol/L}$ 时, 质膜透性反而有所上升, 似与高浓度钙对细胞产生毒副作用有关^[9]. 鉴于30mmol/L 钙浓度降低甜瓜幼苗质膜透性效果最佳, 以下均以此浓度探讨之.

表1 Ca^{2+} 对甜瓜幼苗质膜透性的影响

处理[Ca^{2+}] / $\text{mmol} \cdot \text{L}^{-1}$	质膜透性 / %	相对值
对照	5.50	100.0
10	4.22	76.7
30	3.10	56.4
50	3.28	59.6

2.2 钙对酸雨胁迫下质膜透性的影响

酸雨对植物急性伤害的生理机制之一是破坏膜系统的完整性, 增加其透性^[10]. 表2的数据

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指出, 经2次 pH2. 0酸雨处理的甜瓜幼苗, 叶片质膜透性显著增大, 但经30mmol/L $\text{Ca}(\text{NO}_3)_2$ 预处理的甜瓜植株, 质膜透性保持在低于对照

水平. 说明钙在防护酸雨损伤植物膜系统方面有良好的作用.

2. 3 钙对 CAT 活力与 MDA 含量的影响

表2 Ca^{2+} 对酸雨胁迫下质膜透性、CAT 活力、MDA 含量影响

处理	质膜透性 / %	相对值	CAT 活力 / $\mu\text{molO}_2 \cdot (\text{g}(\text{FW}) \cdot \text{min})^{-1}$	相对值	MDA 含量 / OD_{532}	相对值
对照	5. 5	100. 0	6. 81	100. 0	0. 134	100. 0
pH2. 0酸雨(2次)	9. 2	167. 3	11. 02	161. 8	0. 164	122. 4
Ca^{2+} (1次) + pH2. 0酸雨(2) 次	4. 8	87. 3	19. 70	289. 3	0. 123	91. 8

逆境胁迫下细胞膜受损的原因之一在于自由基积聚和增加, 保护酶系统活性下降, 膜脂过氧化加剧, 膜透性增大. 本实验的结果表明, 经2次 pH2. 0酸雨处理的甜瓜幼苗, MDA 含量较对照提高22. 4%, 但 CAT 活力也应激增加61. 8%. 与此相比, 经钙预处理的植株, CAT 活力为对照的289. 3%, MDA 含量仅为对照的91. 8% (表2) . 表明钙降低甜瓜幼苗质膜透性还同其提高叶片 CAT 活力, 减轻膜脂过氧化程度有关.

2. 4 钙对质膜防护性能的确定

图1表明, 喷洒1次钙的甜瓜幼苗经24h 后进行pH2. 0酸雨处理, 膜透性已显著降低, 以每天喷钙1次, 连续喷钙2次的效果最佳. 若连续喷钙3次以上, 质膜透性开始增加, 但仍低于对照. 对喷钙2次并继续培养1- 10d 的甜瓜幼苗进行pH2. 0的酸雨胁迫的处理和测定叶片质膜的透性, 实验结果指出, 第5d 前质膜透性变化不大,

5d 后才有所增加, 超过7d 时增加趋快, 但也低于对照. 上述结果显示, 以30mmol/L $\text{Ca}(\text{NO}_3)_2$ 连续喷洒甜瓜幼苗2次(间隔24h 喷1次), 可以获得防护质膜酸致损伤的良好效果. 在本实验条件下, 最佳防护时间为7d.

3 讨论

细胞水平上的研究表明, 酸雨对植物酸致损伤的生理机制之一是破坏膜系统完整性, 增加膜透性, 造成物质外渗, 代谢紊乱^[11]. 究其原因, 一是由于酸雨使细胞液质子含量上升, 通过置换作用造成膜上钙的流失, 膜稳定性下降, 透性上升^[12]; 二是使细胞内自由基含量增加, 清除自由基的酶系统活性下降, 大量自由基攻击膜系统, 造成膜脂过氧化, 从而使膜透性增加^[12]. 本文研究结果表明, 30mmol/L $\text{Ca}(\text{NO}_3)_2$ 可稳定甜瓜幼苗叶片的质膜结构, 降低质膜透性, 表现出对酸雨胁迫的良好防护作用. 其机理在于, 外施的大量钙能补偿膜系统上流失的钙, 嵌入膜中, 同膜成分形成复杂的交联结合^[13], 提高膜系统完整性, 降低透性, 表现为直接的抗酸防护作用; 其二, 钙能显著提高自由基清除酶 CAT 的活力, 减少自由基积聚, 减轻其对膜系统的破坏, 体现为间接抗酸保护作用. 至于本实验条件下获得的钙对质膜之保护作用是否适用于其它物种, 尚待进一步研究. 但本实验之结果, 却可为化学调控植物代谢, 增强生理系统功能, 强化对酸雨胁迫的抗御能力, 提供参考.

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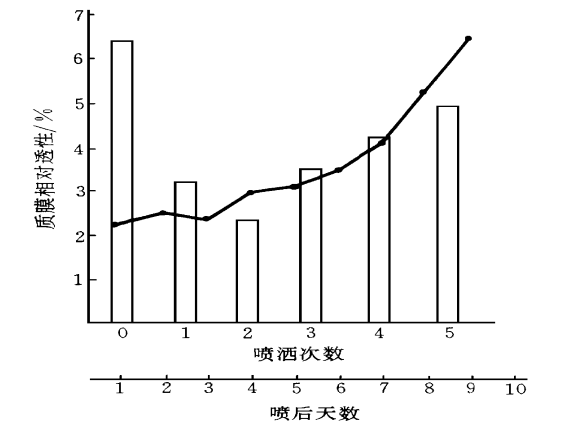


图1 钙最佳防护性能的确定(酸雨: pH2. 0 1次)

冰水冷冻和液氮冷冻浓缩2种方式,前者回收率仅30%,采用液氮可达90%以上(表1).

表1 真空瓶采样液氮冷冻低温浓缩热解吸进样色谱分析回收率和精密度

试样浓度 /ng·L ⁻¹	重复测定值			平均值	变异系数 /%
10	9.04	9.42	9.70	9.26	+ 3.2
	9.21	8.96			

2.5 应用实例

为验证和确认本研究提出和开发的采样、分析检测方法的可靠性和适用性,把本方法应用于某城市污水厂和污水沟周围空气中甲硫醇的测定.本文采用6级恶臭强度表示法和臭气强度(Y)与甲硫醇浓度(X)的函数关系式: $Y = 1.25 \lg X + 1.827$ (X 浓度单位为 ng/L) 计算恶

污水厂的处理设施和污水沟是产生恶臭的污染源,污水厂域容易感觉到臭气味,在污泥排放处有较强感觉.在邻近污水沟和北面的污水厂的测点易感到臭味,居中间的办公楼测点稍稍可感觉到甲硫醇的味道.

3 小结

采用 Tenax GC 低温吸附浓缩和自行改装的国产上分厂8701A 型热解吸进样仪热解进样大口径毛细管色谱柱,研究了空气中甲硫醇的采样-液氮冷冻浓缩-热解析进样-毛细管 GC/FID 分析方法.在所选条件下,检测下限约 0.2ng,回收率和精密度能够达到空气中甲硫醇监测的国家标准要求.

本方法利用甲硫醇低沸点的特性,选取了较低的柱温(35℃),可使甲硫醇组分先于空气中其它许多挥发性物质分离出峰.若应用于多组分的分析,则可以35℃为起点做程序梯度升温色谱分析.

致谢 上分厂郭文奎高工为改装8701A 型热解析进样仪提供了帮助,谨致谢意.

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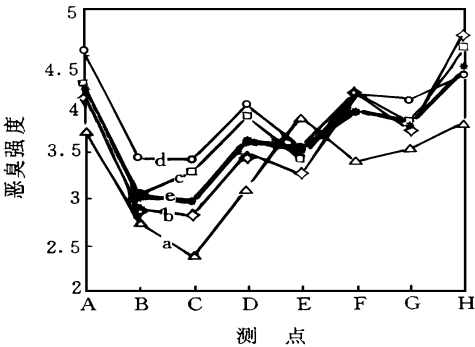


图5 一天中不同时间空气中甲硫醇恶臭强度测定分析实例
A. B. 沟边 C. 办公楼 D. 研究所 E. 格栅 F. 曝气池 G. 浓缩池 H. 排泄处
a. 07:30 b. 11:00 c. 14:00 d. 17:00 e. 平均值
(6级臭气强度分级法:0—1: 无臭,1—2: 勉强可感觉,2—3: 稍可感觉,3—4: 易感觉,4—5: 较强感觉,≥5: 强烈感觉)

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臭强度,结果如图5所示.

这种分布规律可以得到合理的解释;城市

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stability.

Study on Effects of Developing Touristry for Songshan Conservation Area. Song Xiujie and Zhao Tongrun (Beijing Municipal Research Academy of Environmental Protection, 100037): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 57_ 59

In order to evaluate effect of touristry development for Songshan Conservation Area, the investigating site and monitoring water, quality which include surface and underground water, and atmospheric quality were carried out. It was found that the natural landscape of the conservation area was destroyed lightly because of trampling, picking and throwing by tourists and touristry facilities established, but quality of surface water and underground water are fit for National Standard. Atmospheric pollutants are fit for First National Standard. Need to strenthen management of the conservation area was suggested.

Key words: Songshan Conservation Area, environmental effect, touristry development, management.

Effect of Calcium on Cell Membrane Permeability in Acid Rain Stressed *Cucumis melo* Seedling. Zhou Qing and Huang Xiaohua et al. (Dept. of Biology Suzhou Railway Teachers College, Suzhou 215009): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 60_ 61

The relationship of calcium to cell membrane permeability in acid rain stressed *Cucumis melo* seedling has been studied. Calcium obviously decreased cell membrane permeability and protected cell membrane from acid rain insult. Optimum protection effect is that *Cucumis melo* seedling is spraiend continuously two times (once every 24 hours) with concentration of 30mmol/L $\text{Ca}(\text{NO}_3)_2$ at the test conditions. The mechanism perhaps is calcium reagent stabilizing the structure of cell membrane of *Cucumis melo* and raising catalase activity.

Key words: *Cucumis melo* seedling, calcium, cell membrane permeability, acid rain stress.

Spectrophotometric Determination of Manganese with Diantipyryl-(P-Bromo)-Phenylmethane. Yin Jiayuan and Yang Guangyu et al. (Department of Chemistry, Yunnan University, Kunming 650091): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 62_ 63

Diantipyryl-(p-bromo)-phenylmethane (DAPBM) was synthesized and indentified. A highly sensitive spectrophotometric method has been developed for the determination of manganese with DAPBM. In the presence of $\text{Mn}(\text{II})$, $\text{Mn}(\text{VII})$ can reacts with DAPBM to form an orange and yellow product in phosphoric acid medium. The molar absorptivity is $1.28 \times 10^6 \text{ L} \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}$ at 480nm. Beer's law

is in keeping in the range of 0.1 – 0.9 $\mu\text{g}/25\text{ml}$. This method has been applied to the determination of manganese in food and water, the results are satisfiend.

Key words: diantipyryl-(p-bromo)-phenylmethane, spectrophotometric, manganese.

Determination of CH_3SH in Air Using Capillary GC/FID. Wang Lizhong, Lu Yongsen et al. (Key State Lab. of Pollution Control and Resources Reuse, School of Environ. Eng., Tongji University, Shanghai 200092), Wang Wenling (Department of Chemistry, Fudan University, Shanghai 200433): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 64_ 66

The analytical procedure for methylmercaptan in air was investigated which involves four phases of sampling, low temperature concentration with liquid nitrogen, thermal separation and then capillary column GC/FID analysis. Under the conditions selected, a method linear range of 0.2– 200 ng was obtained with a minimal detection limit of 0.2 ng. The recovery was about 92.6% with a relative standard deviation of 3.2%. This Procedure was applied to determine the concentration of methylmercaptan in the environmental air around a waste water plant and a polluted river successfully. The odour strength of the air at different sampling points was also calculated, and the distribution characteristic with methylmercaptan sounded reasonable.

Key words: methylmercaptan, GC/FID analysis, sampling, malodor.

Progresses of Bioremediation Studies and Applications. Lin Li and Yang Huifang (Institute of Microbiology, Chinese Academy of Sciences, Beijing 100080): *Chin. J. Environ. Sci.* **18**(3), 1997, pp. 67_ 71

A review concerns principles and techniques on degradation of xenobiotics and recalcitrants in contaminated site. The basic principle of bioremediation that for special contaminated site different treatment techniques were selected on three factors which are decrease the toxicity of pollutants and increase the bioavailability of pollutants and the bioactivity of microorganisms. The recently advances at in-situ and ex-situ bioremediation techniques are involved in the paper which include adding nutrient, inoculate species, bioventing, land-farming, composting piles, biopiles and slurry techniques. The methods of collecting the site information and of evaluating treatment were discussed also.

Key words: bioremediation, contaminated site, xenobiotics, recalcitrants, microorganisms, bioavailability, bioactivity.

Advances in the Study of Remediation Methods of Heavy Metal-Contaminated Soil. Xia