

研究简报

铬污染对辣椒叶绿素和铁含量 及几种酶活性的影响

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摘要 本文研究了水培和盆栽条件下六价铬污染对辣椒生长量、叶片叶绿素含量、铁含量、超氧化物歧化酶(SOD)活性、过氧化氢酶(CAT)活性以及过氧化物酶(POD)活性的影响。结果表明,铬污染促进了辣椒叶片的衰老。

一、实验材料与方法

辣椒 (*Capsicum annuum*), 品种为华椒一号, 由华中农业大学园艺站提供。

1. 水培试验

营养液中添加微量元素混合液。辣椒幼苗培养在 2L 瓦氏盆中, 每盆 4 株, 13 天后投加分析纯重铬酸钾溶液, 最终浓度梯度为 0、1.0 和 2.0ppm (以纯铬计), 每一处理设 6 次重复。培养 16 天后, 采新鲜嫩叶测定叶绿素含量、SOD、CAT 和 POD 活性。34 天后收获、称重并测定铁的含量。

2. 盆栽试验

(1) 土壤 下蜀系母质发育的黄棕壤(耕地二黄土), 取自华中农业大学农场。土壤基本理化性状为全氮 0.0924 (%)、全磷 0.109

(%)、速效磷 7.84ppm、全钾 1.70 (%)、有效钾 47ppm、有机质 1.04 (%)、pH 5.7。肥底按 N、P₂O₅、K₂O 0.20g/kg 土的浓度用分析纯硫酸铵、磷酸二氢钾和硫酸钾施入。

20 × 20cm 米氏钵每钵装土 6.5kg, 播种前用分析纯重铬酸钾以 0、30ppm 和 50ppm 的浓度(以纯铬计)进行一次性污灌, 每一处理设 6 次重复。直播的种籽出苗后每钵选留 4 株, 种植 35 天后采新鲜嫩叶测定叶绿素含量、SOD、CAT 和 POD 活性以及铁含量, 4 个月后收获、称重。

叶绿素含量测定取新鲜嫩叶于 10ml 比色管中, 加入分析纯甲醇 10ml, 静置过夜后, 用日本 120 型紫外-可见分光光度计测定 663nm 和 645nm 处的光密度, 根据文献 [1] 提供的公式计算叶绿素含量。

表 1 铬污染对辣椒生长量、叶绿素和铁含量以及几种酶活性的影响

	Cr ⁺⁺ (ppm)	生长量* (g·鲜重/钵)	叶绿素含量 (mg/g 鲜重)	铁含量 (ppm)	SOD 活性 (单位/g 鲜重)	CAT 活性 (单位/g 鲜重)	POD 活性 (单位/g 鲜重)
盆栽试验	0	450.43a	2.71a	269.73c	474.27a	749.49a	18.91b
	30	267.61b	2.33b	302.93b	456.89a	447.06b	21.42b
	50	111.26c	2.10b	394.20a	453.50a	357.36b	35.95a
水培试验	0	47.33a	2.78a	159.69b	261.43a	574.61a	7.35b
	1.0	1.72b	0.32b	166.41b	255.82a	81.90b	14.20b
	2.0	1.63b	0.27b	255.71a	239.12a	37.66b	26.86a

* 生长量: 盆栽试验指辣椒果实重量, 水培试验指辣椒植株重量。数据后字母相同者表示彼此间差异不显著, 不同者表示彼此间差异显著 ($P = 0.05$)。

(2) SOD 活性测定 采用 Fridovich 等建立的方法^[2]。光化还原半抑制时酶的用量定义为一个酶单位。

(3) CAT、POD 活性测定 采用 X. H. 波钦诺克介绍的方法^[3]。

(4) 铁含量测定 植物干样用立式行星四筒研磨机(湖北省探矿机械厂生产)玛瑙研磨装置粉碎,过 40 目筛,样品经碳化、灰化处理后,用 1:1 盐酸溶解金属元素,用日本 2280 型原子吸收分光光度计测定铁的含量。

(5) 统计方法 在每一处理的六次重复试验中任取三个样本测定上述项目,用方差分析法和新复极差法^[4]分析、比较各处理间的差异。用三次测量的平均值表示所测项目的量。

二、结果与讨论

如表 1 所示,当土壤和培养溶液中铬的浓度较高时,辣椒生长量、叶片叶绿素含量以及 CAT 活性明显降低,SOD 活性呈下降趋势,而叶片 POD 活性和铁含量则明显升高。

菜豆^[5,6]、水稻^[7]和燕麦^[8]等植物衰老期间,叶片中 SOD 和 CAT 等自由基清除剂的活性明显下降,衰老的烟草叶片中 SOD 活性、CAT 活性和叶绿素含量同步下降^[9],POD 活性明显升高^[10]。受铬污染的辣椒叶片与衰老的植物叶片中 SOD、CAT、POD 活性以及叶绿素含量的变化趋势具有类似

性。铬污染促进了辣椒叶片的衰老。

值得注意的是,受铬污染的辣椒叶片中叶绿素含量和 CAT 活性明显下降,而铁的含量则明显增高。自然衰老的水稻、玉米及苋菜叶片和叶绿体中活性氧 H_2O_2 均比对照明显增高,外加 H_2O_2 刺激水稻叶绿体膜脂过氧化作用, Fe^{2+} 与 H_2O_2 具有协同作用^[11]。铬污染可能以某种方式抑制了辣椒叶片中活性氧清除剂(特别是清除 H_2O_2 的过氧化氢酶)的活性,而同时增多的铁进一步加强了相对过量的 H_2O_2 的破坏力,导致叶绿素解体。这种推测尚待进一步证实。

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• 环境信息 •

电厂排放物转化成有用化学品的新技术

美国劳伦斯实验室(加州贝克利)张锡柱(译音)提出一项新技术,把黄磷随同石灰浆投入除尘洗涤器,约 90% 的硫氧化物和 100% 的氮氧化物大都转化成为磷酸和石膏,但也生成一些磷酸铵。这些化合物可用作或加工成肥料、催化剂、金属处理剂以及

建筑材料。据说这一技术只产生很少量废渣或根本没有废渣。

仲氏摘译自

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Shanghai): *Chin. J. Environ. Sci.*, 11(3), 1990, pp. 24—27

It has been proved that there is a root microecosystem in the process of dyeing wastewater treatment by the hyacinth. With four days' retention, the percentage of COD removal in the oxidation tank, where the hyacinth was planted and its root sterilized with chloride, was 13%. However the percentage of COD removal in ordinary biological oxidation pond without the hyacinth was 15%. In comparison with this, a water hyacinth oxidation tank without sterilization showed higher COD removal percentage of 35% due to existence of a root microecosystem. Similar results were obtained when wastewater containing PVC, detergent and some dyes were treated with the three methods mentioned above. Some organic compounds that could scarcely be absorbed by the hyacinth, for example, those easy to be coagulated or flocules, could be stuck and fixed on the root surface, and then degraded by the root microecosystem.

The Toxicological Effect of Cr (VI) on Chlorophyll and Iron Contents and Activities of Some Enzymes in the Leaves of Pepper (*Capsicum annuum*). Zhou Yiyong, Liu Tongchou, Deng Boer (Dept. of Soil and Agrochemistry, Huazhong Agricultural University, Wuhan): *Chin. J. Environ. Sci.*, 11(3), 1990, pp.28—29

The toxicological effect of Cr(VI) on some biochemical parameters in pepper were studied both in soil culture and in nutrient cultural experiments. The treatments of the heavy metals decreased fresh weight and promoted senescence of the pepper plant by decreasing chlorophyll and activities of superoxide dismutase and catalase as well as increasing iron content and peroxidase activity over control values.

Study on the Pretreatment of Coke-Plant Wastewater by Anaerobic Acidification. Zhao Jianfu, Qian yi, Gu Xiasheng (Dept. of Environmental Engineering, Tsinghua University, Beijing): *Chin. J. Environ. Sci.*, 11(3), 1990, pp.30—34

According to analysis of the constituents and concentrations of organic pollutants in wastewater at Beijing Coke Plant using combined gas chromatography and mass spectrometry (GC/MS), the effect of anaerobic acidification on the bio-treatability of coke-plant wastewater has been studied and the possibility of using anaerobic acidification as pretreatment of aerobic treatment has also been explored. The results described that aerobic biotreatability of coke-plant effluent could obviously increase through 2—6 hours' anaerobic acidification. After 6 hours and 12 hours, anaerobic acidification, COD in the effluent could be removed by 91%, i.e. removal rate increased about

40% more than that without applying anaerobic acidification. As the influent COD of the wastewater was 1780 mg/L, the effluent COD removed to 158 mg/L.

Preparation of Polyaluminum Chloride with Sulfate Ion and Study on Its Properties.

Gao Baoyu et al. (Environmental Science Center, Shandong University, Jinan): *Chin. J. Environ. Sci.*, 11(3), 1990, pp. 34—37

Polyaluminum chloride with sulfate ion (PACS) has been prepared by using aluminum hydroxide, hydrochloric acid, sulfuric acid and sodium carbonate as raw materials, and the properties of PACS have also been studied. The factors affecting the flocculating effect of PACS have been investigated. The experimental results show that the flocculating effect of PACS is influenced by the amount of sulfate ion in PACS, basicity of PACS and pH of water solution. When the molar ratio of Al^{3+} to SO_4^{2-} is in the range of 15 to 17, the flocculating effect of PACS is best.

Problems on Yellow-Colouring of the Wastewater Treated with the Coagulant, Ferrous Salt. Guan Xijun, Wang Fei (Dept. of Environmental Engineering, Qingdao Institute of Architectural Engineering): *Chin. J. Environ. Sci.*, 11(3), 1990, pp.38—40

When ferrous salt is used as a coagulant to treat wastewater, if there exists superfluity in the process of coagulation to sedimentation, purged water will be clear. However, When the purged water is laid aside, it becomes turbid and turns to yellow-colouring. The reason is that oxygen in the air has dissolved in it as time goes on. The authors have proposed a measure to control the phenomenon that a higher pH or an optimal quantity of the mixed coagulant paralleled with tests can avoid color changing.

Application of Inductest in Research of Environmental Mutagens. Ruan Cuicai et al. (Guangxi Cancer Institute, Nanning): *Chin. J. Environ. Sci.*, 11(3), 1990, pp.41—43

The possible mutagenic activity of 35 different chemicals has been tested with inductest, in which S_9 mixture was used as a metabolizing system. The results showed that 13(37%) chemicals had mutagenic activity, 10 of these chemicals gave positive reaction in inductest in the presence of S_9 mixture, three chemicals gave positive reaction in inductest in the presence of S_9 mixture or without it. Some of the chemicals are known as potent mutagens and carcinogens (aflatoxin B_1) or anticancer drugs (mitomycin C). It is considered that inductest is an effective method in research of environmental mutagens.

A Study on Determination of Formic and Acetic Acids in the Atmosphere. Yu Shaocai,