紫露草微核效应与 SO_2 和 NO_x 剂量间关系的试验研究

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摘要 利用紫露草微核技术对大气中重要的污染物 SO_2 和 NO_x 进行了室内外试验。结果表明,紫露草对大气中 SO_2 和 NO_x 较敏感,紫露草微核频率 MCN‰(效应 y)与 SO_2、NO_x 的浓度(剂量 x)的关系在一定的范围内呈正相关。对于 SO_2 当浓度在 0.00—3.75mg/m³ 之间时,对应的微核频率 $y=8.38+4.38x$,$r=0.91$;对于 NO_x 当浓度在 0.00—1.00mg/m³ 之间时,对应的微核频率 $y=4.84+14.94x$,$r=0.99$;对于 SO_2 和 NO_x,当 SO_2 浓度在 0.00—0.75mg/m³,NO_x 浓度在 0.00—1.00mg/m³ 之间时,对应的微核频率 $y=2.92+17.05x_1+15.60x_2$,$R=0.926$;并且 NO_x 的剂量对微核的效应要大于 SO_2 对微核的效应,SO_2、NO_x 的剂量对微核效应呈拮抗作用。确认此法可用于大气环境污染状态的侦察性监测。

关键词 紫露草,微核效应,SO_2,NO_x,剂量效应。

大气污染能引起植物的多种反应,植物对环境污染的这种指示作用,在国内外的环境监测与评价中得到日益广泛的应用。为了更进一步探讨紫露草微核频率与大气环境中重要污染物 SO_2 及 NO_x 浓度之间的对应关系,本文就这种效应与剂量之间的数量关系进行了室内外试验。

1 材料与方法

1.1 试验材料

沼泽紫露草(*Tradescantia paludosa*)3 号是由湖北省环境监测中心站提供的原属美国的品种,经繁殖栽培,生长良好,细胞分裂正常,本底微核率稳定。

1.2 试验方法

采用静态人工薰气的方法。国家气体发生中心提供的标准气体,用清洁空气稀释,配制成已知剂量的试验系列。将被处理的紫露草花枝暴露在密封的薰气箱(处理箱)中。试验按照图 1 装置进行。

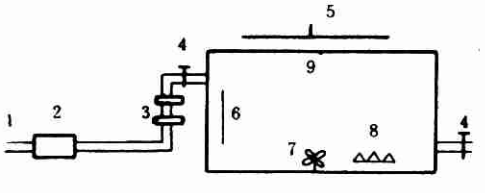

图 1 紫露草暴露染毒实验装置

1. 进气孔 2. 空气压缩机 3. 活性炭柱 4. 阀门 5. 日光灯 6. 温度计 7. 搅拌器 8. 供试物

1.3 测定方法

将经过暴露染毒的花序(处理 6h),通过恢复培养,固定,保存,解离等常规方法最后经染色制成玻片,置显微镜下,统计四分体细胞中微核频率(见图 2、图 3)。

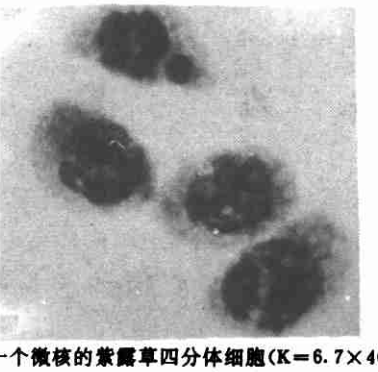

图 2 含一个微核的紫露草四分体细胞(K=6.7×40×4 倍)

2 结果分析

2.1 SO_2 的剂量与微核效应的关系

试验结果(见表 1)经回归分析得出 SO_2 的剂量与微核效应间的关系(见表 2)。经显著性检验,表 2 中的结果(2)表明剂量与效应间相关性极显著。

对结果(2)进行 t 检验:$t=4.91>t_{0.01,5}=2.571$,证明相关性达极显著。

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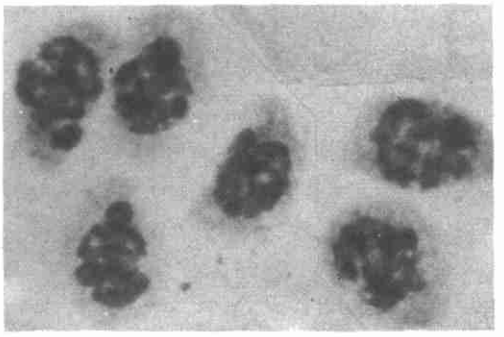

图3　含多个微核的紫露草四分体细胞(K=6.7×40×4倍)

上述结果表明当 SO_2 浓度在0.00—3.75 mg/m³之间时，紫露草微核效应与 SO_2 的剂量呈线性关系(2)。

2.2　NO_x 的剂量与微核效应的关系

试验结果(见表3)经回归分析得出 NO_x 的剂量与微核效应之间的关系(见表4)。经显著性检验表4中的结果(5)表明剂量与效应间的相关性达极显著。

表1　SO_2 的剂量与微核效应间试验结果(22.3℃)

SO_2 剂(mg/m³)	0.00	0.02	0.04	0.11	0.38	0.75	3.75	11.25
平均微核率(MCN%)	4.32	6.84	9.49	9.56	10.30	16.44	23.79	15.09

表2　SO_2 的剂量与微核效应之间的关系

SO_2 的剂量(mg/m³) x	微核效应 y	回归方程 $y=a+bx$	样本数 n	相关系数 r	置信度 a
0.00—11.25	4.32—23.79	$y=10.44+0.75x$(1)	320	0.49	
0.00—3.75	4.32—23.79	$y=8.38+4.38x$(2)	280	0.91	0.01

表3　NO_x 的剂与微核效应间试验结果(25.1℃)

NO_x 剂量(mg/m³)	0.00	0.05	0.10	0.15	0.30	0.50	1.00	5.00	15.00
平均微核频率(MCN%)	4.33	4.83	6.95	7.13	9.89	12.76	19.34	10.36	10.12

表4　NO_x 的剂量与微核效应间关系

NO_x 的剂量(mg/m³) x	微核效应 y	回归方程 $y=a+bx$	样本数 n	相关系数 r	置信度 a
0.00—15.00	4.33—19.34	$y=9.23+0.12x$(3)	360	0.13	
0.00—5.00	4.33—19.34	$y=8.76+0.77x$(4)	320	0.26	
0.00—1.00	4.33—19.34	$y=4.84+14.94x$(5)	280	0.99	0.01

表5　SO_2 和 NO_x 的剂量与微核效应间试验结果(23.4℃)

SO_2 剂量(mg/m³)	0.00	0.04	0.08	0.11	0.50	0.10	0.22	0.38	0.75	0.75	0.00
NO_x 剂量(mg/m³)	0.00	0.05	0.10	0.15	0.10	0.50	0.33	0.50	1.00	0.00	1.00
平均微核频率(MCN%)	4.32	7.75	10.41	11.20	12.20	12.30	12.52	13.57	20.09	16.44	19.34

表6　SO_2 和 NO_x 的剂量与微核效应间关系

SO_2 的剂量 x_1	NO_x 的剂量 x_2	微核效应 y	回归方程 $y=a+b_1x_1+b_2x_2$	相关系数 r	样本数 n	置信度 a
0.00—0.75	0.00—1.00	4.32—20.09	$y=2.92+17.04x_1+15.60x_2$(6)	0.93	220	0.01

对结果(5)进行 t 检验：$t=20.66>t_{0.01,5}=4.03$，证明相关性达极显著。上述结果表明当 NO_x 剂量在0.00—1.00mg/m³之间时，紫露草微核效应与 NO_x 的剂量呈线性关系。(5)

2.3 SO_2 与 NO_x 混合气剂量与微核效应的关系

试验结果(见表5)经回归分析得出 SO_2 和 NO_x 混合气的剂量与微核效应间关系(见表6)。经显著性检验表6中结果(6)表明相关极显著。

对结果(6)进行方差分析(见表7)和 F 测验(见表8)。

对上述结果(6)进一步计算分析得出:

$b_1' = 0.482$, $b'_2 = 0.548$;

$R_{y\cdot 12} = 0.93$, $r_{y1\cdot 2} = 0.73$, $r_{y2\cdot 1} = 0.78$, $r_{12\cdot y} = -0.33$;

表7 多元回归方差分析

变异来源	OF	SS	MS	F	$F_{0.05}$	$F_{0.01}$	显著度
二元回归	2	1716.22	858.11	24.07	4.46	8.65	$P<0.01$
离回归	8	285.25	35.66				
总	10	2001.48					

上述结果表明,SO_2 与 NO_x 混合气的剂量与微核效应间相关性达极显著,并且 NO_x 的剂量对微核效应要比 SO_2 为高,二者对微核效应呈拮抗作用。当 SO_2 剂量为 0.00—0.75mg/m³ 及 NO_x 剂量为 0.00—1.00mg/m³ 时,其混合气的剂量与微核效应之间的关系呈二元线性关系(6)。

表8 偏回归 F 测验

变异来源	DF	SS	MS	F	$F_{0.01(1,8)}$	显著度
因 x_1 回归	1	767.30	767.30	21.52	11.25	$P<0.01$
因 x_2 回归	1	916.09	916.09	25.69	11.25	$P<0.01$
离回归	8	285.25				

2.4 现场暴露监测结果

现场监测结果(见表9)经与化学方法比较,认为二者结果基本接近。

表9 现场监测暴露染毒组的结果及分析

点位	功能区	温度(℃)	风向	SO_2 剂量(mg/m³)	NO_x 剂量(mg/m³)	理论 MCN(%)	实测 MCN(%)	误差
监测站	文化区	22.7	E	0.008	0.022	3.40	3.88	0.48
焦炉前	工业区	22.2	E	0.044	0.030	4.63	6.14	1.51
化产车间	工业区	19.0	NW	0.119	0.041	5.59	8.78	3.19
车站口	商业交通区	23.3	NW	0.008	0.049	3.82	6.00	2.18
车站口岗楼	商业交通区	25.9	W	0.066	0.112	5.79	9.77	3.98
技校	混合区	26.0	ESE	0.025	0.025	3.73	5.35	1.62

3 结论

(1)SO_2 剂量与 NO_x 剂量和微核效应的关系只存在部分正相关。对于 SO_2 剂量在 0.00—3.75mg/m³ 范围内,与对应的微核效应呈线性关系:$y = 8.38 + 4.38x$ ($r = 0.91$)。对于 NO_x 当剂量在 0.00—1.00mg/m³ 范围内与对应微核效应呈线性关系:$y = 4.84 + 14.94x$ ($r = 0.99$)。

(2)对于 SO_2 和 NO_x 混合气体,当 SO_2 剂量为 0.00—0.75mg/m³ 及 NO_x 剂量在 0.00—1.00mg/m³ 范围内,与对应的微核效应呈二元线性关系:$y = 2.92 + 17.05x_1 + 15.60x_2$ ($R = 0.926$),并且 NO_x 对微核的效应要高于 SO_2,二者对微核效应呈拮抗作用。

(3)从现场暴露结果可以看出,根据室内试验理论推出结果与实测结果基本一致。这说明室内试验得出的理论上数量关系有效,基本准确,证明此方法可以用于大气环境污染状态警报性监测。理论值与实测值的误差,主要是由于暴露染毒处理时,受大气中其它因子的污染毒物所致。

(4)SO_2 或 NO_x 在高剂量时对应的微核频率值反而降低,主要由于超大剂量造成细胞死亡或导致细胞分裂延缓而引起。

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Abstracts

Chinese Journal of Environmental Science

Study on a Dose - Response Relationship of *Tradescantia* Micronucleus to Atmospheric SO_2 and NO_x. Luo Buyun, Liu Wenxia et al. (Baoji Station of Environmental Protection and Monitoring, Baoji 721006): *Chin. J. Environ. Sci*., **15**(2), 1994, pp. 62—64

A study has been carried out on monitoring atmospheric SO_2 and NO_x by using *Tradescantia* micronucleus technique. The results showed that *Tradescantia* was sensitive to a variation in the atmospheric concentration of SO_2 and NO_x. A *Tradescantia* micronucleus response (frequency) was closely related to the domain doses (concentrations) of SO_2 and NO_x in the air. A linear regression equation of the *Tradescantia* micronucleus frequency as a function of SO_2 and NO_x doses had been deduced. It was found that the response to SO_2 was inferior and opposite to a response to NO_x. This can be used to properly estimate the concentrations of SO_2 and NO_x in the air and to assess the level of air pollution.

Key words: *tradescantia* micronucleus frequency, dose-response relationship, sulfur dioxide, nitrogen oxides.

Study on an Express Determination method of Lead in Stream Sediment by Spectrofluorimetry. Huang Chengzhi, Chi Xizeng (Department of Chemistry, Beijing Normal University, Beijing 100875): *Chin. J. Environ. Sci*., **15**(2), 1994, pp. 65—68

A simple and express determination method of lead was established by spectrofluorimetry. The complex of Pb^{2+} with Cl^{-1}, at a concentration ranging from 1.4 to 2.0 mol/L, fluoresced at 485.0nm, which could be applied to the determination of trace Pb^{2+} when the pH was lower than 6.8 and the complex was excited by 262.5 nm ultraviolet light. Under the conditions of excitation bandpass 10.0nm, emission bandpass 20.0 nm and at the temperature of 23±3℃, the equation of $\triangle F = 1.01\times10^5 c + 0.020$ ($n = 13$, $r = 0.9998$) was followed for 1.0×10^{-7}—1.0×10^{-5} mol/L Pb^{2+}, the determination limit was 5.3×10^{-8}mol/L ($K = 3$). The analitical results of lead in reference stream sediment were compatible with the reference values with the recovery ratios going from 95.9 to 104.9% ($n = 10$), RSD=2.1%.

Key words: stream sediment, spectrofluorimetry, lead.

Determination of Acetonitrile, Acrylonitrile, Aniline and Nitrobenzene in Water and Discharged Industrial Water by Direct Aqueous Injection Gas Chromatography. Hou Ding' yuan, Tang Jianfei (Institute of Suzhou Enviromental Science, Suzhou 215004): *Chin. J. Environ. Sci*., **15**(2), 1994, pp. 69—70

Direct aqueous injection (DAI) gas chromatography is a rapid, simple and accurate method for the determination of nitrogenous organic pollutant at μg/L levels in water and discharged industrial water. In this method a 0.53 mm id. fused silica capillary column was used in order to enhance resolution. Bacause of the high sensitivity of nitrogen phosphorous detector a 1μl sample injection is enough for the determination with satisfactory accuracy, precision and sensitivity.

Key words: direct aqueous injection gas chromatography, nitrogenous organic pollutant, nitrogen phosphorous detector.

Study on Simulating the Biodegradation of Mixed Organic Pollutants in Songhuajing River. Yuan Xing, Ding Yunzheng et al. (Dept. of Environmental Science, Northeast Normal University, Changchun 130024): *Chin. J. Environ. Sci*., **15**(2), 1994, pp. 71—74

A study was made to simulate the biodegradation process of a mixed system of 21 organic pollutants which were detectable in the songhuajiang River, by using the water samples and sediments collected from different sites of the River as the sources of microorganism. The results showed that the main factors affecting the biodegradation included the structures of compounds, the sources of microorganism, and the period of acclimation. Under the conditions of acclimation, the rate of the biodegradation of mixed organic pollutants at a low concentration was found to fit the equation of first order reaction kinetics.

Key words: mixed organic pollutants, biodegradation, simulation.

Method for Preparing a Standard Sulfide Solution and Its Stability. Wen Zhiming, Qi Min et al. (Dept. of Environmental Protection, Fushun Research Institute of Petroleum and Petrochemicals, Fushun 113001): *Chin. J. Environ. Sci*., **15**(2), 1994, pp. 75—76

A method for preparing a standard sulfide solution has been established by examining the following variables: form of sulfide precipitation, effects of trace heavy metals, dissolved oxygen level in water, acidity of solution, purity of zinc acetate- sodium acetate, and effect of irradiation. The stability of such a standard sulfide solution was also discussed. A standard sulfide solution prepared by this method can be kept stable for at least 2 months in the range of