公路边土壤和水稻中铅的分布、累积及临界含量

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摘要 在距公路 5、10、50、100、200 m 准备收割的稻田中同时采集土壤及稻米样品。对 2 条公路的样品分析结果表 明,汽车尾气中铅的污染大多集中在公路两侧 50 m 左右的范围内。土壤自身性质对路边土壤及水稻中铅的分布、 累积具有显著影响。轻壤水稻土中铅的累积量小于重壤水稻土,但轻壤水稻糙米的含铅量却高于重壤。轻壤中土 壤含铅量和糙米含铅量之间具有相关关系。探讨了公路边土壤的临界含量问题,推算出轻壤中此值为 58 mg/kg, 远小于盆栽实验和污灌地区。

关键词 铅,公路,土壤,水稻,临界含量。

汽车尾气是环境中铅的重要来源。行驶在公路上的汽车,其排放废气中的铅沉降造成公路两侧的土壤及所生长植物的铅污染^[1,2]。笔者通过现场调查,在距公路不同距离、准备收获的稻田中同时采集土壤和稻米样品,对2条公路进行了这种断面研究。结果表明,公路边土壤中铅的分布、累积与距离公路远近和土壤性质有密切联系,糙米含铅量受土壤性质影响显著。由于公路2侧铅污染具有自身的特点,土壤临界含量往往小于盆栽实验和污灌地区。本文得出的结论有助于准确预测新建公路的铅污染水平。

1 调查、采样及测试

1.1 现场调查

2条公路的断面采样点均设在扬州市。断面 1位于高沙土农业区,土壤为旱改水而成的渗 育型水稻土,母土为灰潮土,成土母质为长江 冲积物。土壤特点是质地轻,粗粉砂含量高,易 漏水漏肥;地下水位较低,水分以垂直下渗作用 为主,土壤养分含量低,常见元素和微量元素 含量均不高。土壤主要性质如表1所示。

断面 2 设在里下河农业区里运河东测,其 成土母质为湖相沉积和黄淮冲积交互母质。石灰 反应较强,地下水位1m左右,灌排条件好,土 壤肥力较高,为高产稳产土壤,表1列出了其主 要性质。

2个采样断面所在地区的农业气候相近,

分别引用长江水和运河水进行灌溉。

表1 设置断面土壤的主要性质。

		-		
项目	断面1		断面 2	
- 壤质地	轻壤		重壤至轻粘	
有机质含量(g/kg)	13.4	ţ	24	
全磷(g/kg)	1.54		1.27	
速效磷(mg/kg)	4-5		6-7	
速效钾(mg/kg)	50-70	•	120-130	

1.2 样品采集

在距公路路基 5、10、50、100、200 m 准备收 割的稻田中布点,每一点周围 1 m² 左右范围内 采集土样和水稻稻米样品,采样深度 0—15 cm, 土样和稻米样——对应采集。按四分法取够分析 用量,分别装入塑料袋,带回实验室分析。

1.3 样品测试

土壤样品风干后,磨碎,过100、200 目尼龙 筛,用王水、高氯酸(均为分析纯)消解,火焰原 子吸收法测定。

稻米用去离子水快速冲洗,烘干、脱壳、研 磨,用硝酸、高氯酸(均为优级纯)消解,石墨炉 原子吸收法测定。

2 结果与讨论

2.1 路边土壤中铅的分布、累积特征

2.1.1 铅在土壤中的分布

* 北京工业大学环境化学系 收稿日期: 1995-03 23 图1是2个断面耕层土壤中铅含量随距离 公路远近的分布曲线。曲线a表明,断面1在距 公路50m左右范围内,土壤含铅量较高;在 100m以外地区,铅含量显著降低,趋于稳定, 表明汽车尾气的铅污染主要集中在公路两侧50 m左右的范围内。由于路面高于稻田1.5m左 右,土壤中的铅并没有在公路边缘达到最大值。 以江苏省A层上壤中铅元素的背景值24.4mg/ kg^[3]作为评价标准(如图1所示),可以看出,在 距公路50m左右的范围内,汽车尾气已经造成 了土壤轻度的铅污染。当距离50m以外后,污 染程度逐渐减轻。在距100m以外地区,土壤中 的铅含量同背景值接近,土壤受到汽车尾气的 铅污染很弱。

断面 2 土壤含铅量在距公路 50 m 左右的采 样点达到最大值。随着距公路距离的增加,土壤 含铅量有减少的趋势,但铅分布的规律性不如 断面 1 明显。从图 1 曲线 b 可以看出,断面 2 各 采样点的土壤含铅量均高于背景值,说明汽车 尾气对路边土壤的铅污染范围较大。



2.1.2 铅在土壤中的累积

汽油中的四烷基铅以 PbCl₂、PbBrCl、PbBr₂ 等形式排放到大气中,沉降在公路两侧。随着公 路运营时间的增加,铅的沉降量增加。一般地, 在预测新建公路在运营期间汽车尾气对路边土 壤的铅污染时,车流量和运营时间通常作为主 要考虑因素。车流量大,运营时间长,排入土壤 中的铅多。相应地,土壤含铅量的预测值高。在 本研究中,断面1所临公路为日平均交通量 5000辆以上、公路等级为二级的国道,路面宽 度7-8m。断面2所临公路为乡间公路,路面宽 度4-5m,修建时间短,且车流量远小于断面 1所临的国道。采用常规的预测方法,断面1土 壤的含铅量应该高于断面2。而图1的结果表 明,断面1各点土壤的平均、最高、最低含铅量 均低于断面2的相应值。

土壤中铅的累积是一种复杂的化学过程, 累积量取决于进入土壤的铅的总量以及土壤自 身的性质。由现场调查结果可知,断面1质地为 轻壤,有机质含量低。可以推测出汽车尾气中的 铅化合物落入土壤溶于灌溉水后,只有少量为 土壤物质吸附或与有机物形成不溶性配合物而 滞留在耕层土壤,大部分铅随水分的下渗而移 出。所以,尽管有铅不断进入土壤,但由于铅的 滞留能力弱,因此铅在断面1土壤中的累积量 较小。断面2土壤质地为重壤至轻粘,有机质含 量高,石灰反应较强。土壤的这些特征有利于铅 在土壤中的滞留。虽然排入断面2土壤中铅的 总量少于断面1,但土壤对铅的滞留能力相对断 面1来说较强,所以铅在断面2的累积量大于 断面1。

在准确预测新建公路运营期间汽车尾气对 公路两侧土壤中造成的铅污染时,应对公路两 侧土壤的质地、有机质含量、酸碱性、阳离子代 换量等,作出全面的调查分析。土壤性质不同, 对铅的滞留能力不同。充分考虑影响污染的各种 因素,而不简单地以车流量和运营时间去预测 铅污染水平,会大大减少预测误差。

2.2 路边水稻对铅的吸收及与土壤性质的关系

图 2 是 2 个断面各点糙米含铅量与距离公 路远近的关系曲线。断面 1 轻壤水稻土生长的 水稻,在距公路 50m 左右范围内,糙米含铅量 较高。随着距公路距离的增加,糙米含铅量显 著降低。距公路 100m 以外的土壤,其糙米含铅 量趋于稳定。比较图 1a 和图 2 可以看出,轻壤 水稻土中土壤含铅量与糙米含铅量具有显著的 • 68 •

相关关系:

y = -0.61 + 0.028x (r = 0.93) 式中 x、y 分别代表土壤和糙米中的含铅量。

在断面 2 重壤至轻粘水稻土生长的水稻, 其土壤与糙米中的铅含量之间不具有显著相关 关系。



a. 断面 1 b. 断面 2

对比图1和图2不难看出,在路边200m范 围内,断面1土壤的平均含铅量(26.8 mg/kg) 低于断面 2(29.2 mg/kg), 而其各采样点糙米 的平均含铅量(0.134 mg/kg)却高于断面 2 (0.066 mg/kg)。这表明水稻对铅的吸收明显受 土壤性质及土壤含铅量的影响, 生长在轻壤水 稻土的水稻, 对铅的吸收、累积大于重壤至轻粘 水稻土。断面1所在地区地下水位较低,水分垂 直下渗作用较强,由于土壤对铅的滞留能力弱, 溶于水的汽车尾气中的各种铅化合物不断随水 向下传输,在水稻根部为水稻所吸收。并沿水稻 植株向上迁移,积累于果实中。而水稻根部周围 土壤中可被吸收的铅又不断随着土壤表面水分 的下渗而得到补充, 使根部的铅处于一种"相对 饱合"状态。这种过程持续作用的结果使铅在稻 米中的积累量增加。而在重壤轻粘水稻土中,如 前所述,土壤自身的化学行为使沉降在土壤中 的铅绝大部分转化为不溶性铅化物,滞留在土 壤表层,铅在土壤中的纵向迁移作用弱,故在 水稻根部可被吸收的铅较少,稻米中铅的积累 量少于轻壤。

2.3 路边土壤铅的临界含量

临界含量是制定土壤环境容量标准的主要 依据。目前这个问题研究多见于盆栽实验和污水 灌溉地区^[4, 5],铅的临界含量一般在 10²-10³ mg/kg 之间,有关公路两侧铅的土壤临界含量 的研究报道很少。

盆栽实验是将铅一次性加入到供试土壤中, 使土壤铅含量达到某一值后进行试验,污灌地 区使用的灌溉污水,铅浓度往往很高。在以上2 种试验中,铅是在短时间内大量地进入到土壤 的。而公路两侧铅进入土壤的过程不同于上面试 验。汽车尾气中的铅排入大气后,沉降在路边一 定范围内的土壤中。铅进入土壤的数量虽然很 少,但在作物生长期间不间断地进入,这个特 点决定了公路两侧铅对作物的污染历程不同于 盆栽实验和污灌地区,特别是在长时间浸水的 水稻土中,铅的污染处于一种动态平衡之中。根 据公路两侧土壤铅污染的这种特点,不妨将其 临界含量称为动态临界含量。由前面轻壤水稻土 中土壤和糙米含铅量之间的相关关系,以我国 食品卫生标准铅含量不超过 1mg/kg 为依据, 得到铅的动态临界含量为 58mg/kg, 这一数值 远小于盆栽实验和污灌地区。

对于以大气降水、降尘为污染物主要输入源 的地区,例如公路两侧及矿山、冶炼厂周围,如 果表层土壤对污染物的滞留能力弱,污染物在 土壤中的迁移能力强,即使土壤中污染物含量 很低,也会造成作物根部在不断吸收污染物的 同时,又有污染物迁移至作物根部,引起污染 物在作物中的不断累积等。所以,动态临界含量 往往能比较准确地反映污染的实际水平。

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erected with the mineral saccharide from the Zhuozhou Paper Mill in Hebi Province. By feeding the rice and maize straw treated with the mineral saccharide, sheep had a daliy weight increase by 22.8% and 9.25%, respectively, as compared to those treated with ammonia.

Key words: pulping black liquor, straw feed, waste recycle.

Determination of Dioxin-like PCB in Both Commercially Available PCBs in China and Stack Ash from PCB Incinerator. Li Lingjun and Jiang Ke (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); Chin. J. Environ. Sci., 16(6), 1995, pp. 55-58

Considering the fact that the toxicity of PCBs congeners is related to the substituted positions of chlorine atoms, the evaluation of PCBs environmental toxicity depends on the analysis of dioxinlike PCBs, Multi-layer silica column and basic alumina column clean-ups were applied to the pretreatment of samples. The composition and content of dioxin-like PCB congeners in two commercially available PCB in China were determined by GC/MS, and were compared with those from other countries. The determination results of dioxin-like PCB in the stack ash sample from PCBs incinerator showed that the content and toxicity of dioxin-like PCB in stack ash were diminished by 20000 and 50000 times, respectively.

Key words: dioxin-like PCB, incineration, GC/MS.

Study on the Interference Patterns in the 4-Amino Antipyrine Photometric Determination of Volatile Phenols in Wastewater. Yuan Cunguang et al. (Dept. of Chemical Engineering, University of Petroleum, Dongying 257062), Peng Li (Dept. of Environmental Protection, China Petroleum and Natural Gas Corp., Beijing 100724); Chin. J. Environ. Sci., 16(6), 1995, pp. 59-62

The interference patterns with different mineral oils (crude oil, machine oil and diesel oil), aniline, some metal ions and ClO^- , etc. in the 4-AAP photometric determination of volatile phenols were studied. The recovery of phenols in the presence of different amounts of interference substances was determined spearately. Then, the total recovery equation Y was established. The true

concentration $C_{\rm T}$ of volatile phenols in wastewater was determined with the value $C_{\rm D}$ found by 4-AAP method and the equation Y. The result from standard addition experiment with mixed interference substances shows that its relative error to the calculated value by the equation Y is below 5%. The determined result of wastewater sample is coincident with the results determined by the derivative photometric method. This method can be used for the determination of volatile phenols in oil-field wastewater.

Key words: volatile phenols, interference patterns, 4-amino antipyrine, photometry.

Accumulation of Asphalt Fractions from Total Suspended Particulate Matters in Various Plant Species. He Kebin (Dept. of Environ. Eng., Tsinghua University, Beijing 100084); Chin. J. Environ. Sci., 16(6), 1995, pp. 63-65

With reference to ASTM D4124, asphalt fractions, including polar aromatics, naphthene aromatics and saturates, were characterized both in various plant samples and in total suspended particulate sample. In comparison to the results of background plant samples and asphalt cement sample from highway surface, it is concluded that asphalt makes the main contributions to the accumulation of the three organic fractions mentioned above in plant species. For the plant samples used in this research, the concentrations of the three fractions are 0. 29 - 3.07 mg polar aromatics, 0.89 - 3.89 mg naphthene aromatics and 0.37 -1.53 mg saturates per gram dry plant materials. Key words: total suspended particulate, asphalt fraction, plant, accumulation.

Study on the Distribution Accumulation and Critical Level of Lead in Soil and Rice Along Road Sides. Cao Lixin et al. (Environmental Monito-ring Centre, Ministry of Communications, Beijing 100036): Chin. J. Environ. Sci., 16(6), 1995, pp. 66-68

The soil and rice samples were collected simultaneously at the sites of 5, 10, 50, 100 and 200 meters away from road, respectively. The analysis results of samples collected along two roads demonstrated that the pollution of lead from automobile exhaust gas was within a range of about 50 m along the roads. The soil characteristics had a significant effect on the distribution and accumulation of lead in soil and rice. The accumulation amount of lead in light loam was less thatn that in heavy loam, but the lead content of brown rice was more than that in heavy one. Correlation between the lead content of soil and that of brown rice had been shown in light loam. Based on it, the critical level of soil along road side had been discussed. The predicted value was 58 mg/kg, much less than that of pot experiments and the area irrigated with waste water.

Key words: soil, rice, lead, road, critical level.

A Study on the Exchange Process of Heavy Metals Species in the Changjiang River Estuary. Shao Mihua (Institute of Marine Environment Protection, SOA, Dalian, 116023), Wang Zhengfang (The Second Institute of Oceanography, SOA, Hangzhou 310012): Chin. J. Environ. Sci., 16(6), 1995, pp. 69-72

The present paper deats with the exchange process and distribution of particulate species, soluble species, and various other species of suspended particles trace metals from waterbody across the main axis of the Changjiang river diluted water in flood season. The variation trend of its state shows that trace metals along horizontal profile tended to tranfer from particulate forms into soluble form, and the translation priorty of metals forms was Ni>Fe Co>Cu>Mn>Pb. The vertical changes of their chemical forms in aqueous environment was adsorbed by Fe-Mn oxides and organic detritus; the metals bound Fe-Mn oxides combined species was the most important speciation; and the transerable order of metals forms is pb>Cu>Mn>Fe>Ni>Co. Finally, the environmental status and pollution level in the water column of Changjiang estuary was discussed.

Key words: trace metals, soluble species, suspended particles, Changjiang river.

Progress in the Investigation on Plant Availability of Soil Trace Metals. Jin Qian et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); Chin. J. Environ, Sci., 16(6), 1995, pp. 73-75

A review was given on the progress in the research on plant availability of soil trace metals. major factors influencing bioavailability such as plant species, physico-chemical characteristics of soil, and the nature and speciation of trace metals were discussed. The relationship between soil extractable values and plant uptake, and the change of bioavailability resulting from the application of sewage sludge were also included.

Key words: soil, trace metals, bioavailability.

Application and Development of Immobilized Microbial Cells Technology in the Biological Denitrification Process of Wastewater. Wang Lei and Lan Shucheng (Beijing Municipal Research Academy of Environmental Protection. Beijing 100037); Chin. J. Environ. Sci., 16(6), 1995, pp. 76-78

A review was given on the application and development of immobilized microbial cells technology in the bilological denitrification process of wastewater, including general conditions, peculiarities and existing problems of nitrification and denitrification of wastewater, technology and application of microbial cells immobilization in the denitrification process of wastewater; materials and process of immobilization, current situation of research and application practical application in large-scale wastewater treatment; the existing problems and solving ways, and the prospects and trend of this technology.

Key Words: microbial cells immobilization, wastewater, biological denitrification.

Identification of Bio-macromolecular (DNA and protein) Adducts by Mass Spectrometry. Long Yaoting (Research Center for Eco-Environmental Sciences. Chinese Academy of Sciences, Beijing, 100085). Chin. J. Environ. Sci., 16(6), 1995, pp. 79-82

Application of Mass Spectrometry in the study on biomacromolecular (DNA & Protein) adducts was described in the present paper. The recent results of alkyl adducts, aromatic amine adducts, and protein adducts studied by mass spectrometry were also discussed. The successful examples of applying the recently developed Electrospary Ionization Mass Spectrometry (ESIMS) to identification of protein Adducts was also reviwed. The experimental results show that ESIMS provided new evidence of bio-macromolecular adducts.

Key words,: adducts, mass spectrometry biomacromolecule.