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Distribution of HCHs and DDTs in Agricultural Soil of Pudong New Area, Shanghai

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Abstract

To study HCHs and DDTs contents and their spatial distribution in the agricultural soil of Pudong, Shanghai, the residue amounts of HCHs and DDTs in 238 surface soil samples were determined. The results showed that concentrations of HCHs ranged from 0.001 to 0.050 mg/kg and DDTs ranged from 0.001 to 0.067 mg/kg, with both occurrences of 100%. The spatial analysis indicated that there was the obvious regional differentiation in soil pollution. Compared with HCHs, soil quality was contaminated more seriously by DDTs in the study area. In addition, areas with high contents of HCHs were mainly located in Jichang, Chuansha and Sanlin, whereas areas with high concentrations of DDTs mainly lied in Sanlin, Jichang, Tang, Chuansha and Caolu.

Keywords: Agricultural soil; HCHs; DDTs; Pudong New Area

1. Introduction

Organochlorine pesticides are one of the first 12 types of banned substances restricted or banned globally under the Stockholm Convention on Persistent Organic Pollutants (Jones et al., 1999). These compounds are environmentally persistent, toxic, apt to bioaccumulate, and have adverse effects on human and animals. Being typical organic pollutants, HCHs and DDTs were studied from various perspectives, such as migration transformation (Beyer et al., 2000), bioavailability (Yao et al., 2007), residue characteristics and special distribution (Yuan et al., 2001; Gong et al., 2003) and their effects on human health (Morisawa et al., 2002). Studies from home and abroad show that residue of HCHs and DDTs was frequently found in agricultural countries and even in more developed industrial countries (Harner et al., 1999); still soil in part of China is in high content of HCHs and DDTs (Gong et al., 2003; An et al., 2005). It can not be ignored that HCHs and DDTs residues are one important factor to form chemical pollutant load in soil.

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From current similar studies home and abroad, more work still needs to be done for researches on HCHs and DDTs residues and their distribution status in soil by the method of high density sampling at county range. Taking Shanghai Putong suburb as the study area and basing on GIS technique and large amount of data, this article will explore the pollution status and accumulation principles in Shanghai Pudong suburb agricultural soil and provide data and scientific basis for soil environment quality comprehensive managements in this area.

2. Material and Methods

2.1 The study area

Pudong New Area (31°07′N-31°23′N, 121°27′E-121°48′E) is located to the west of the East China Sea and to the east of Huangpu River in the Shanghai municipal region, covering an area of 533.45 km^2(Fig.1).

The soil types of Pudong New Area mainly include paddy soil, fluvio-aquic soil, coastal saline soil and yellow-brown soil. The paddy soil and fluvio-aquic soil belong to agricultural soil formed by the process of tillage, oriented cultivation based on physical soil formation, covering more

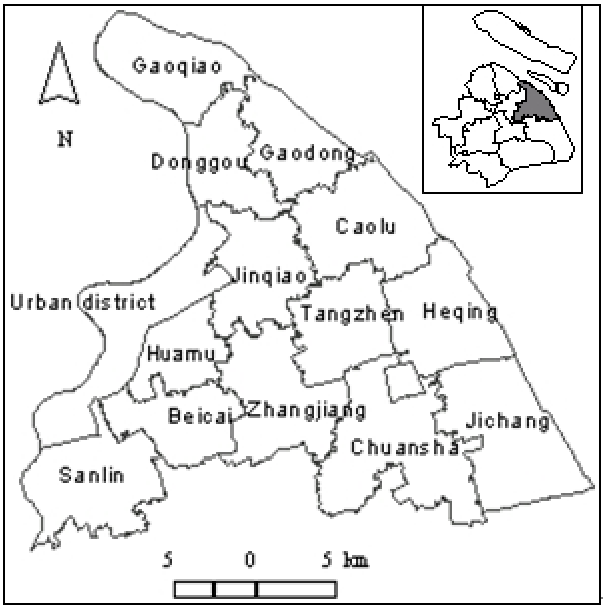

Figure 1. Distribution of Sampling sites

than 70% of the study area. Additionally, the costal saline soil is located along the coastal areas influenced by the sea water intrusion an immersion, occupying about 16% of the total (Xv et al., 2004). The study area include Gaoqiao, Donggou, Gaodong, Jinqiao, Caolu, Tang town, Caolu, Beicai, Sanlin, Zhangjiang, Chuansha, Heqing and Jichang town (Fig.1).

2.2 Sample collection

In principle, a sample point was selected in each village considering agricultural division, crop distribution and cropping characteristics. Density adjustment of the sample was also needed according to the specific topography, land use and coverage features as well as soil type. A total of 2413 samples were collected as a result. Each soil sample was a mixture of 5 sub-samples taken within a range of 200 m2 at the sampling site. Simultaneously, GPS positioning was adopted for each sample point (fig.2).

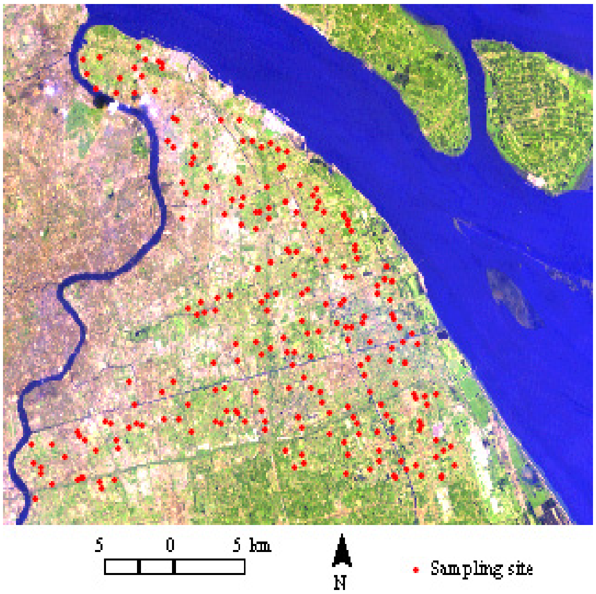

Fig.2. Distribution of sampling sites

Soil samples were homogenized and air-dried before extraction in a 60 mesh sieve. The determination of residues of DDTs and HCHs in soils was according to the GB/T14550-93 (China National Pesticide Residue Standard, 1999). All data were subject to strict quality control procedures (An et al., 2004): ①spiked samples: Each batch of analyzed samples (20 or so) should have one extra for spiked sample; ②blank samples: each batch of analyzed samples should have one blank sample to determine the cleanliness of reagents and containers; ③parallel samples: each batch of analyzed samples should have two to three parallel samples (20%) to determine reproductively of results; ④Spike recovery: once per week. Add two types of standard concentration samples in samples to be tested (with 1 to 2 magnitude difference), parallel for three to five times to decide the reliability of results.

2.3 Data processing

In this study, ARC/INFO7.1 and SPSS12.0 were employed in data processing and analysis, ArcView3.2 was used as the graphics-drawing software.

3. Results and Discussions

3.1 Statistical analysis of the content of OCPs in the soil

HCHs and DDTs in soil analysis results were shown in Table 1.

Table 1 shows that in the collected soil samples, the HCHs and DDTs residues were in the range of 0.001 ~ 0.050 mg/kg and 0.001 ~ 0.067 mg/kg respectively, and the average was 0.007 mg/kg, 0.008 mg/kg. Additionally, the occurrence rates were both 100%, indicating that organochlorine pesticide residues were prevalent in the soil. Judging from the skewness and kurtosis coefficient, the DDTs were normally distributed while HCHs were not. What is more, after logarithmic transformation, the concentrations of HCHs do not agree with logarithmic normal distribution either, with skewness and kurtosis coefficients at 4.30 and 0.39 respectively. The variation coefficient represents the mean variation of data of the samples. HCHs and DDTs have variation coefficients of 84.2% and 66.9% respectively, indicating strong level of variability.

TABLE 1 Statistics of HCH and DDT

Item	**HCH**	**DDT**
Number of samples	238	238
Min(mg/kg)	0.001	0.001
Max(mg/kg)	0.050	0.067
Average (mg/kg)	0.007	0.008
Standard deviation(mg/kg)	0.006	0.005
Detection rate (%)	100	100
Coefficient of variation (%)	84.2	66.9
Kurtosis	43.805	2.974
Skewness	5.991	1.406

3.2 The spatial distribution characteristics of organochlo- rine pesticides in the soil

Kriging interpolation is a reliable method of unbiased valuation of regional variables. On basis of HCHs and DDTs test value semivariance in the study area, by Ordinary Kriging interpolation methods of ArcGIS 8.3 software, unbiased valuations of OCPs content in the soil of study area were obtained against the test values at sampling sites. Interpolation results were shown in Fig.3.

As can be seen from Fig.3, the study area was polluted lightly by HCHs, while was relatively heavily polluted by DDTs. From the point of spatial distribution, the existence of HCHs and DDTs has significant regional differentiation; the distribution of HCHs was concentrative, while that of DDTs was in the wider regions.

Taking the quality standard of soil environment (GB15618-1995) issued by state environmental protection administration as the evaluation standard, the HCHs residue amount is all under primary standard in the agricultural soil of study area; DDTs residue amount is above primary standard in some regions. The regions with soil residues of HCHs beyond the amount of 0.02 mg/kg covering the area of 191 km^2, accounted for 0.4% of the total study area, mainly concentrated in Jichang, Sanlin, Chuansha and Tang Town; in which residues above the amount of 0.04 mg/kg covering the area of 30.1 km^2, accounted for 0.05% of the study area, mainly concentrated in Jichang, while other administrative region has much lower content of residues, with the residual volume of less than 0.01 mg/kg. Still there are a small number of areas ranging from 0.01 mg/kg and 0.05 mg/kg. Seeing from DDTs special distribution, residues above the amount of 0.02mg/kg covering the area of 3460 km^2, accounted for 6.6% of the study area; residues above the amount of 0.05mg/kg covering the area of 129 km^2, accounted for 0.2% of the study area, polluted area concentrated at Sanlin, Jichang, Chuansha and Tang Town.

The use of pesticides such as HCHs and DDTs in Shanghai suburb began in 50s to 60s in 20th century and was mostly widespread in 70s. Studies show (Gong et al., 2003); pesticide applications are the main source of HCHs and DDTs in soil. From HCHs pollution distribution, it is possible there are new sources for HCHs and DDTs pollutant. Judging from this study area, HCHs and DDTs residues in Chuansha wastewater irrigation zone, which is located in Pudong New Area, were both very low. That's to say; in the sewage irrigation area HCHs and DDTs residues were not necessarily high.

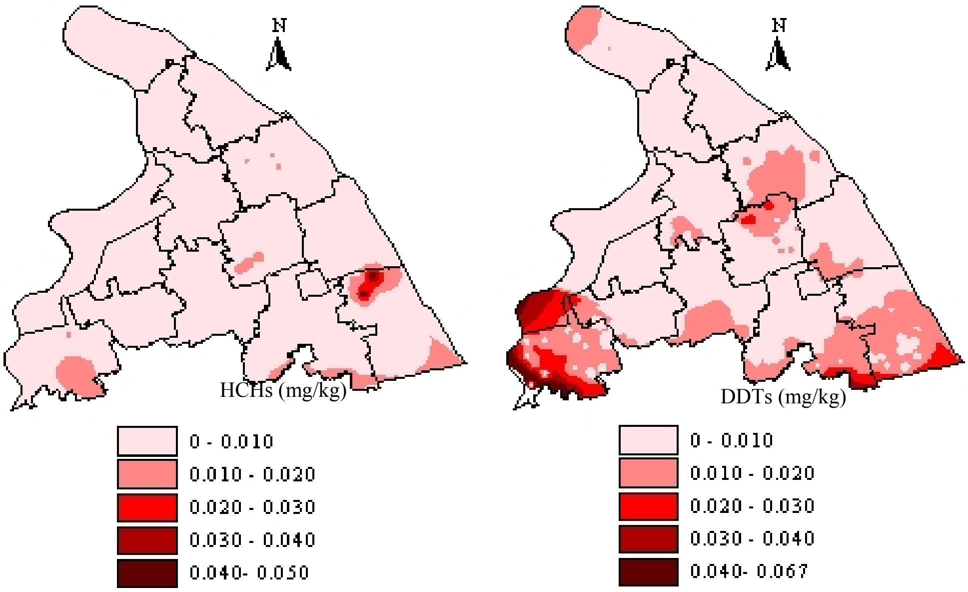

Fig. 3 The distribution of HCHs and DDTs contents in agricultural soils of Shanghai suburb

4. Conclusions

(1) Statistics show, DDTs agree with normal distribution whereas HCHs do not agree with normal distribution or logarithmic normal distribution. The concentrations of HCHs ranged from 0.001 to 0.050 mg/kg and DDTs ranged from 0.001 to 0.067 mg/kg, with mean value at 0.007 mg/kg and 0.008 mg/kg respectively. The relevant occurrence is 100% for both, indicating Organochlorine pesticide residues are prevalent in soil.

(2) The spatial distribution indicated that the study area was less contaminated by the HCHs, but relatively heavier polluted by DDTs in the study area. The spatial analysis indicated that there was an obvious regional differentiation in soil pollution. Compared with HCHs, soil quality was contaminated more seriously by DDTs in the study area. Areas with high contents of HCHs were mainly located in Jichang, Chuansha and Sanlin Town while areas with high concentrations of DDTs mainly lied in Sanlin, Jichang, Tang and Chuansha Town.

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