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Dicofol application resulted in high DDTs residue in cotton fields from northern Jiangsu province, China

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Abstract

Dicofol with high impurity of DDT compounds is still widely used in agricultural practice such as cotton cultivation and becomes an important source of DDT pollution in China. In this study, investigations on the DDT residues in cotton fields from northern Jiangsu province, China were conducted. The results showed that DDTs in cotton soil were much higher than other mode of land use. The DDTs levels ranged from 4.2 to 678.6 ng g^{-1}, with a mean concentration of 190.4 ng g^{-1}, of which the most abundant compounds were *p,p′*-DDE (mean of 129.38 ng g^{-1}), *p,p′*-DDT (mean of 26.57 ng g^{-1}) and *o,p′*-DDT (mean of 16.92 ng g^{-1}). The concentrations of *o,p′*-DDT and *o,p′*-DDE were significantly higher ($p < 0.05$) in topsoil (0–10 cm) than in subsoil (10–20 cm), while other DDT compounds were not. Source apportionment showed that dicofol-type DDT accounted for up to 80% of the DDTs residue. All the results indicated that dicofol applications resulted in serious DDT pollution in cotton fields. Our work provided implications for reasons why there was no apparent decrease of DDT level in China.
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Keywords: Organochlorine pesticide; DDT; Dicofol; Cotton field

1. Introduction

Because of their persistence, bioaccumulation, toxicity and long-range atmospheric transport, the pollution of organochlorine pesticides (OCPs) such as DDT is still widely concerned [1–4].

China has been a major producer and consumer of DDT since the 1950s until its production ban in 1983 [5,6]. Over the 30 years the total production of DDT was about 0.4 million tonnes, accounting for nearly 20% of the global production. After 1983, DDT production still continues primarily due to the demand of malaria control and production of dicofol. Additionally, China has requested for specific exemption of DDT under the Stockholm Convention till 2009. Statistical data showed that from 1988 to 2002, the average annual DDT production was about 6000 t in China, of which, nearly 80% was for dicofol production [7]. The dicofol production reduced gradually in recent years (e.g. the production was 1518.3 t in year 2005, only 30% of that in year 2000) and would be completely eliminated in the future several years [8], however, in the production procedure, dicofol contains high impurity of DDT-related compounds, and therefore becomes an important source of DDT in China [9,10]. Dicofol with impurity of DDTs above the national standards is still available in the Chinese market. An investigation on the impurity content in commercial dicofol revealed the average contents of *o,p′*-DDT, intermediate 2,2,2-trichloro-1,1-bis(4-chlorophenyl)-1-chloroethane (α-chloro-DDT), *o,p′*-DDE, and *p,p′*-DDT in the samples were as high as 114, 69, 44 and 17 g/kg dicofol, respectively [7].

Large applications of dicofol in agricultural practice especially in cotton cultivation have resulted in serious environmental pollution in China. A study on the atmospheric concentration revealed that the concentrations of DDT in China were much higher than other parts in East Asia [11]. Air samples collected over Taihu Lake during the summer of 2002 displayed very high concentrations of DDTs and the authors suggested dicofol was the significant important source of DDT [12]. The investigation on the DDT in dated sedimentary cores from the Pearl River estuary, in the south of china, found there was little

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sign of any declining trend in DDT concentrations [10]. High concentrations of DDT were also detected in different food items including marine products, eggs, dried fruits and vegetables [13]. Moreover, a survey on the DDT contamination in human milk revealed that the Chinese population exhibited rather high concentrations of DDTs [14].

As far as the temporal and spatial characteristics of dicofol application were concerned, Jiangsu province might be subject to serious DDT pollution because of the large cotton cultivation areas and the corresponding intensive dicofol application. For example, in 1998, cotton cultivation area was 0.42 million ha. In recent years, cotton cultivation in Jiangsu province is mainly located in the north and accounts for 96.4% of total cultivation areas. Consequently, the DDT pollution in the north was truly higher than in the south [15]. Therefore, it was considered that the north cotton cultivation area was one of the significant source areas of atmospheric DDT in the south of Jiangsu province [12].

However, few efforts have been made on the DDT residue in cotton fields, and it is not known yet to what extent the cotton fields were polluted due to dicofol application. Moreover, there is too little information to answer the questions as follows: (1) Are the DDT residues in soil consistent with the DDT impurity in dicofol? (2) Are the DDTs residue patterns in soil consistent with the pattern in air of southern Jiangsu province e.g. around Taihu Lake? (3) Does the technical DDT historically applied still persist in the cotton field? If anything, what is the proportion for dicofol and technical DDT? In an attempt to provide implications for these questions as well as for the risk assessment and pesticide management, the DDT residue in the cotton fields of northern Jiangsu province was studied and some characteristics of DDT residue were found.

2. Materials and methods

2.1. Study area and sample collection

Soil samples were collected from Tongzhou and Qidong (see Fig. 1), where the cotton cultivation had a long history and in 2006 the cultivation areas were about 6800 ha, accounting for 86% of the cotton cultivation areas and 10% of the total arable field of Nantong. Nantong is located in the north of Jiangsu province and in the northern bank of the estuary of Yangtze River. The topography of this area is characterized by plain. The climate is northern subtropical. The average annual temperature is 15.1 °C and the normal annual precipitation is 1060 mm. The dominant soil types are silt loam. Twenty-nine cotton soil samples were collected in August 2006, and five vegetable soil samples were also sampled with the expectation that these sites could be used as “background soils”. At each sample location, five cores were scooped with a pre-cleaned stainless steel scoop from a 100 m × 100 m plot and then mixed to provide a composite sample. Topsoil sample (from 0 to 10 cm depth) and subsoil sample (10 to 20 cm) were separately mixed for each sample location. The samples were sealed in polythene bags, air-dried, then passed through 2-mm sieve and stored in cool condition till analysis.

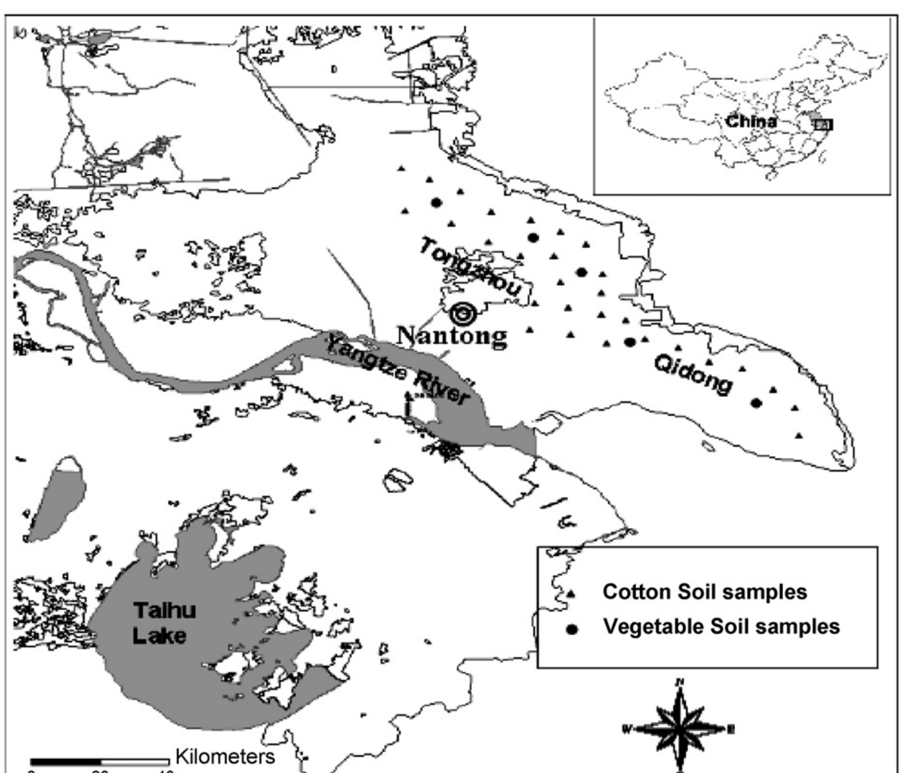

Fig. 1. Map of Nantong showing soil sampling locations.

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