Preliminary Study on the Application of Municipal Sludge to Agriculture

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Sludge is one type of special municipal wastes and it is increasingly urgent to manage sludge as sewage treatment becomes widespread in cities throughout the world. It is still necessary to look for some practical way to treat sludge in developing countries although there are already many approaches in sludge disposal (Wu, 1981; Jin & Liu, 1988; Wang et al., 1999; Wei et al., 1998; Davis, 1996; Yao, 2000).

Guilin, with 565 km² of urban area and a population of 600, 000, is a heart of a world-famous scenic tourist area in Guangxi Zhuang Autonomous Region in Southern China. There are four sewage treatment plants and about 100 tones of sludge, with some 80% moisture, are produced per day. At present, the sludge is simply used in farmland for crops. Unfortunately, there exist some sanitary problems, such as its bad smell and attractiveness to flies. It is of a great environmental significance to dispose the sludge properly. In general, the heavy metal concentration in the sludge from sewage treatment in Guilin is low because there are few factories discharging wastewater containing heavy metal. Therefore, this study investigated the feasibility of making organic complex fertilizer using composted sludge.

MATERIALS AND METHODS

All of the sludge samples in the investigation were taken from the Fourth Sewage Treatment Plant in Guilin. First, the sludge was sampled and analyzed for plant nutrients, including organic matter, nitrogen, phosphorus and potassium. Then, the sludge was composted. The process was classified into aerobic fermentation step and anaerobic fermentation step (Ge et al., 1995). After the moisture content of the sludge was reduced from 80% to about 60%, 20 cm thick sludge and 2 cm of thick sawdust were put alternately into a stack-box which was made of bricks and was 1m in height with a bottom of 4m × 4m. It took two weeks to digest the sludge under aerobic conditions using a forced air supply. In the first week, air

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was fed into the sludge pile at the frequency of 10 minutes per hour by a blower with a power of 200 w and working efficiency of 4 m³ of air per minute. The frequency was decreased to 5 minutes per hour in the second week. After aerobic fermentation, the sludge was put away at room temperature for 30 days. Finally, the composted sludge was made into a specific organic complex fertilizer after adding nitrogen, phosphorus and potassium, mixing and granule formation.

In order to determine the effect of the organic complex sludge fertilizer, it was applied to crops, including spring rice (from April to July, 1999) and autumn rice (from July to October 1998), and sugarcane field from July 1998 to January 2000. There were four types of fertilizers tested in the experiments: (1) organic complex sludge fertilizer for rice (SR), with 11% nitrogen, 4% phosphorus and 5% potassium. (2) organic complex sludge fertilizer for sugarcane (SS), with 14.3% nitrogen, 4% phosphorus and 5% potassium. (3) complex fertilizer bought on the market (CF), with 13% nitrogen, 5% phosphorus and 7% potassium, and (4) Mixed fertilizer using urea, calcium-magnesium phosphate and potassium chloride (MF), with 15% nitrogen, 5% phosphorus and 5% potassium.

Each plot of rice was 13.3m². SR and CF were used as base fertilizer at three nitrogen levels, i.e., 3kg nitrogen per Mu (1 Mu is equal to 66.67 m²), 4.5kg per Mu and 6 kg per Mu. There were also three control plots where no base fertilizer was applied. There were seven sugarcane plots, each plot measuring 21.6m². SS and MF were used at three different nitrogen levels, 18.5 kg nitrogen per Mu, 23 kg nitrogen per Mu and 30 kg nitrogen per Mu, while CF was used at a rate of 23 kg nitrogen per Mu, which was the amount of fertilizer commonly used in sugarcane field in the Guilin region. In all cases, 50% of the fertilizer was used as base fertilizer and the other 50% as top-dressing.

Protection rows were constructed around the plots. Field management was the same for every plot. The crops were observed and recorded regularly. When they were harvested, the output of each plot was independently calculated.

In order to detect heavy metal contamination, the sludge from the Fourth Sewage Treatment Plant and rice harvested from the spring rice plots were sampled and analyzed for heavy metals. The plant nutrients of this sludge were analyzed in the Guilin Botanical Research Institute. Heavy metal analyses were completed in the Key Laboratory of Central South University using plasma atomic emission spectrometry.

RESULTS AND DISCUSSION

The dried sludge from the Fourth Sewage Treatment Plant contained 39.6% organic matter, on average. Nitrogen, phosphorus and potassium content were 48.3g/kg, 21.1g/kg and 8.5 g/kg on average, respectively. The plant nutrient content was the same as or a little higher than the sludge in other cities such as Guangzhou, and Tianjin in China (Table 1).

In the rice field experiments the methods of rice seeding and growing were almost