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RECYCLED SEWAGE SLUDGE: A STEP TO SUSTAINABLE AGRICULTURE

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ABSTRACT

Sewage sludge obtained as a byproduct of a typical wastewater treatment plant is being viewed as an excellent substitute for the commercially available chemical fertilizers in light of their potential for improving soil properties and for providing important nutrient and trace element supplements that are essential for plant growth. Due to high cost of mineral fertilizers and escalating trends in their prices, there is an increasing trend of using sewage sludge in agriculture, especially under intensive cropping in arid and semi arid regions, where the soil is low in organic matter due to rapid oxidation. Application of sewage sludge to agricultural soils may provide a sustainable and economical solution to the safe disposal of large amount of organic waste while beneficially recycling the nutrients into the soil. This paper therefore presents a review on the nutrient value of sewage sludge and the beneficial aspects of its application on agricultural land.

Key words: Sewage sludge, Fertilizers, Sustainable agriculture, Land application.

INTRODUCTION

The way agriculture is foreseen today has changed. What was once considered as a means of obtaining food has now changed into a business for sustaining economy- for example a crop of corn that once was grown only for food now triples as fuel and even a component of biodegradable plastics. This increased demand, along with many other factors, is forcing us to consider the sustainability of our current farming practices. Due to high cost of mineral fertilizers and escalating trends in their prices, there is an increasing trend of using organic fertilizers in agriculture, especially under intensive cropping in arid and semi arid regions of the country.

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Sewage sludge obtained as a byproduct of a wastewater treatment plant is known to be rich source of nutrients (nitrogen and phosphorous), organic matter and trace elements like boron, manganese, copper, molybdenum and zinc[1] that are beneficial for plant growth and better yield[2]. Therefore, it can be considered as a suitable substitute for commercial fertilizers and its use as fertilizer on agricultural land has been reported to decrease the requirement for commercial fertilizers[3].

Due to rapid increase in population and urbanization, sewage sludge production has also been on the rise. It is estimated that Indian cities and towns together generate approximately 19127 tones of sludge per day[4]. To manage waste water treatment plants effectively and efficiently, it is necessary to extract waste sludge, in order to prevent their accumulation into the system. Land application is generally considered to be the most economical and beneficial way of sludge disposal compared to other methods of disposal such as incineration and landfilling, which are expensive and associated with environmental hazards[5]. Recycling of sludge for agricultural purpose not only provides an appealing solution for sustainable management of sludge but also closes the loop of nutrient cycling, which is integral to all natural processes[6].

Characterization of sewage sludge

The utilization of sewage sludge in agriculture is gaining popularity as a source of waste disposal. However, characterization of sewage sludge is important before application to soil for agricultural purposes. Such characterization helps in determining the potential of sewage sludge for nutrient supplementation for increasing plant yields. In addition, the information will be useful for determining suitable rate of application of sewage sludge and for investigating pollutant risks that may be associated with the use of sewage sludge[7].

Sewage sludge is a rich source of nutrients (nitrogen and phosphorous), organic matter and trace elements like boron, manganese, copper, molybdenum and zinc[1]. Application of sludge has been observed to improve the physico-chemical and biological properties of soils, which in turn facilitates better growth of plants.[8] Sludge increases the humus content of the soil.[9] An increase in organic matter reduces the bulk density, increases aggregate stability, increases water holding capacity of soils and promotes greater water infiltration. Organic matter also influences nutrient storage and turnover, soil biota and diversity as well as vulnerability to erosion. Sludge application in fine textured soil increases the infiltration capacity and also the air recirculation. By contrast, the increased bulk density of fine textured soils without sludge amendment causes poor aeration, which adversely affects plant growth. Sludge is also reported to increase the porosity, field capacity and wilting point.[10]

A higher C/N ratios in the sludge samples is an indication that there is limited mobilization of nitrogen by incorporation into cell mass, which make the nitrogen contents available at a later period, when it is needed by most for plants during the period of growth. The high cation exchange capacities of the sludge samples along with nitrogen content indicates a positive outcome for application of sludge for agricultural purposes because such association of nitrogen with cation exchange capacity means slow release of nutrients (greater period of availability). In addition, increase in cation exchange capacity results in reduced mobility of potentially toxic and inhibitory heavy metals. The sludge samples, therefore, carry low risk of potential heavy metal toxicity with respect to agricultural uses[7].

Sewage sludge as an important resource for agriculture

Since sewage sludge is rich in organic matter and many essential micro and macro elements, it can serve as an effective fertilizer replacement for these important nutrients. A high organic matter content of sewage sludge help in improving the physical, chemical, and biological properties of soil[11-19]. Maintaining adequate organic matter content is essential for maintaining soil fertility and productivity. Therefore, application of sewage sludge to soils of arid and semi arid regions is especially beneficial as the soils in these regions are low in organic matter due to rapid oxidation. Moreover, a high organic matter level helps to sequester carbon and mitigate greenhouse gas emissions[6].

Sewage sludge contains several essential micronutrients for plants (e.g., B, Cl, Cu, Fe, Mn, Mo, and Zn), which are not provided by most conventional chemical fertilizers[20]. Therefore, it can be applied on micronutrient-deficient soils[21,22]. Numerous researchers have reported an increase in the bioavailability of metals in sludge amended soil[20,23-27].

Moreover, the primary nutrients in sewage sludge are in organic forms, not as soluble as those in chemical fertilizers, and are released more slowly. Therefore, sewage sludge can nourish the plants at a slower rate over a longer period of time with higher use efficiency and a lower likelihood of polluting groundwater when applied rate is appropriate[28]. The organic carbon in sludge amended soil can increase as far as three fold compared to inorganic fertilizer amended soils[29].

Use of sewage sludge for crop husbandry

Being an important organic fertilizer, sewage sludge is used for crop production in both the developed and developing countries of the world. Considerable research has been accomplished worldwide on the use of sewage sludge on soil and crop. Many

investigations, with different climatic and soils conditions, have reported a substantial increase in plant growth, crop yield and biomass production upon sewage sludge application[8,23-49].

Use of sewage sludge for fruit and vegetable production

Organic manures are not enough to meet the requirements of fruit and vegetable production. Sewage sludge being a valuable input can be used for fruit and vegetable production in view of its high organic matter content and rich macro and micro nutrients[44,45,50-53].

Use of sewage sludge in dairy pastures

The main potential use of sewage sludge is as a fertilizer and/or soil conditioner to improve growth of the dairy pasture and maintain the structure of soil. Reports suggest that repeated applications of sewage sludge have no harmful effects on soil and forage quality and result in better forage production than unfertilized control[20,54].

Use of sewage sludge in forestry

According to European commission (2001) the overall goal of sewage sludge addition to forestry is to improve physical, chemical and biological properties of soil and fertility status for creating more favorable conditions for establishment of vegetation or improve plant growth in the existing forests. Untreated sludge cake is mostly used in the forestry. In intensive forestry production, sludge application may be performed just after sowing, thinning, or clear filling. In established forest, sludge application could potentially occur throughout the year, if good practices are observed and local conditions are acceptable[6].

CONCLUSION

Recovery and re-use of nutrients and organic products found in human urine and feces are not a new process and have been used since many centuries by various cultures around the world. Recycling of organic waste through land application serves several purposes. Reuse of organic waste not only helps to reduce large amount of waste produced by the society but also cut down the cost of its disposal, besides, providing a beneficial way for recycling of nutrients lost from soil. Since sewage sludge is rich in organic matter and many macro and micronutrients, recycling of sludge for agricultural purpose seems to be an

appealing solution for sustainable management of sludge. Sewage sludge production is rapidly increasing resulting from the continuous increase in population, urbanization and industrialization. Keeping in view the escalating trends in the prices of chemical fertilizers and the excellent fertilizing and soil amendment properties of sewage sludge, land application of sewage sludge appears to be the most convenient, beneficial and cost effective method of sludge disposal especially in a developing country like India where agriculture forms the major occupation to sustain the country's economy. However, caution needs to be exercised when sludge is repeatedly applied or applied at levels above the agronomic recommended rate as heavy metals, organic pollutants, and pathogens in sewage sludge, though at low concentration, may pose a threat to the environment and animal and human health with time.

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