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Usage of Sludge in Agricultural Applications

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Abstract

The aim of this study was to evaluate the use of waste sludge from treatment plants and to use them in agricultural applications. With the increasing population, the amount of waste sludge from the treatment plants is increasing in proportion to the same amount. However, one of the important problems in the facilities is the storage problem, so there is an alternative solution for what to do with the excess sludge. The disposal method that has been on the agenda in recent years is the application of the sludge after the treatment to agricultural land. The content of the sludge is also an important factor. Substances that should not be on agricultural land should not be applied to the land. In case of necessary conditions, it has great advantages both in terms of agricultural land and increase plant.

Keywords: Agriculture, Environment, Treatment Sludge

Review article

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INTRODUCTION

Today, the amount of water used in increasing population is increasing. Considering that this situation will cause further problems, Wastewater Treatment Plants are being constructed. During the day, houses, workplaces, common areas etc. The waters we use come to these facilities as waste water and they are rendered harmless to the environment by providing them. Treatment sludge is formed as a result of the increase of domestic and industrial water. Depending on the components in which the sludge is used. Mud to be used in agricultural areas should not contain heavy metal and toxic compounds. For this reason, it is more convenient to use sludge in the treatment of domestic wastewater.

It is an effective recycling method in terms of evaluation of agriculture, prevention of environmental pollution and protection of natural resources. This method is the cheapest waste removal method compared to other evaluation methods. The sewage sludge supports the reduction of fertilization costs as a source of organic fertilizers with the nutrients it contains. In addition, the improvement effect of some properties of soil in the treatment sludge is another important advantage that supports its use (Akat et al., 2015).

The increase in the number of wastewater treatment plants in our country every day raises the issue of how to evaluate the treatment sludge. However, it cannot be said that there is sufficient knowledge and research findings about the use of treatment sludges. The current practice is that wastewater sludges should be disposed of as waste by landfills or unconsciously in agricultural production by farmers near the plant. Environmental pollution will be prevented by the use of treatment sludge, which is a great source of organic matter, in the field (Bilgin et al., 2002).

Treatment Sludge

Treatment sludges are wastes generated by the process in domestic and industrial wastewater treatment plants. Treatment sludge is a product of the wastewater treatment and the sludge disposal has become a more vital need as the amount of sludge that is accumulated every day and thus the amount of storage for the sludge is increased (Aslan 2018).

In all pathogenic organisms, pollutants and wastewater treatment plants in the wastewater, the chemicals used in the processes are converted into sludge in order to reach the discharge limits of the water. For this reason, sludge contains harmful substances. These muds, which are of great harm to human health and the environment, are not evaluable for any process but have good calorific value. For this reason, these sludges can be recovered as energy by being disposed of in appropriate thermal processes (Anonymous 2018).

Sewage Sludge Sources

Generally the mud originates from 3 main categories. These;

- Purification sludge from drinking water treatment plants
- Refining sludge from waste water treatment plants
- Industrial wastewater is the treatment sludge from the treatment plant.

Depending on the type and purpose of treatment, the types of treatment sludge vary.

- Pre-sedimentation sludge formed by collapsible solids
- Chemical sludge from chemical treatment and coagulation

- Biological sludge from biological treatment
- Advanced Treatment Sludge (Yıldız et. al., 2009)

Composition of Treatment Sludges

Sewage sludge, according to the type of industrial organization in which it occurs; organic compounds, acids, alkalis, metal salts, phenols, oxidants, dyes, sulfates, hydrocarbons, oils, Fe, Cu, Al, Hg, Cd, As, Co, Pb, Cr, organic phosphorus and nitrogen can contain substances such as (Taşatar, 1997).

In order to be able to use the slurries in the agricultural areas, attention should be paid to the nutrients, pH level, salinity and presence of heavy metals.

The Effects of Nutrients in the Sludge on Plants:

Plants need many nutrients to grow and grow from seed. These nutrients;

Macro Nutrients:

Carbon is an element that is received from the air by air (atmosphere) in the form of CO_2. It is the basic molecular component of carbohydrates, proteins, fats and nucleic acids. It is the plant nutrient element that is used in the photosynthesis process of plants (Jones ve Jacobsen, 2001; Fageria et al., 2011).

Hydrogen is an element taken from water by the plants in H_2O form. It is a plant nutrient that plays a central role in plant metabolism. It is important to provide ion balance due to being the main reducing agent. It also has a key role in the energy relations between cells. Responsible for many biochemical reactions in the plant (Jones ve Jacobsen, 2001; Fageria et al., 2011).

It takes *oxygen* from plant water and air in O_2 and H_2O forms. It is a nutrient that is very similar to carbon in terms of its functions in the plant. Therefore, all organic compounds of living organisms are actually present. The oxygen element that forms the structure of carbohydrates is also required for respiration (Jones ve Jacobsen, 2001; Fageria et al., 2011).

Nitrogen, together with water, is the most frequent nutrient. That's why we see more plant growth control as a nutrient element (Çepel, 1996; Gardiner ve Miller, 2008; Fageria, 2009). Because there is no nitrogen compound in the inorganic parent material from the bedrock and the bedrock. The source of nitrogen in nature is the atmosphere. There is also a significant amount of nitrogen in the hydrosphere and living things. The main depot of nitrogen in the soil is organic matter. Plants can be used in nitrogen as a result of the decomposition of organic matter over time (Çepel, 1996; Kantarcı, 2000; Boşgelmez et al., 2001).

Potassium plays a major role in multiple events taking place in plants. It is used by plants in the activation of numerous enzymes and coenzymes, photosynthesis, protein formation, starch formation and sugar transfer. It increases the water balance of the plant with the cell sap and thus increases the resistance against drought. It has a positive effect on summer drought and frost resistance (Brady, 1990; Kantarcı, 2000; McCauley et al., 2009).

Calcium is the third most used plant nutrient. The plant is an integral part of the cell wall and is therefore known as the plant nutrient element that regulates the cell wall structure (Plaster, 1992; McCauley et al., 2009).

The source of *phosphorus* in the soil is apatite mineral. Apatite mineral is present in flour apatite or hydroxyapatite compositions. Generally, while crystalline schists such as quartzites, phyllites and micaschists contain a small amount of phosphorus, the amount of phosphorus in basalt and similar basic magmatic rocks is higher. It can be used by phosphorus plants which are released by fragmentation of rocks and minerals. There are also organic phosphorus compounds in the soil because of the presence of phosphorus in the structure of organic matter (Çepel, 1996; Aktaş & Ateş, 1998; Kantarcı, 2000).

The source of *magnesium* is biotite, augite, hornblende, olivine, serpentine, chlorite, dolomite. Magnesium in the soil is found in various forms according to the mineralogical composition of the main rock (Çepel, 1996; Kantarcı 2000; Kacar & Katkat 2010). Minerals such as biotite, dolomite, chlorite, serpentine and olivine contain magnesium. The magnesium in the soil can be water-soluble, changeable and non-volatile. These three forms of magnesium are in a dynamic equilibrium with each other (Boşgelmez et al., 2001).

Sulfur is an essential nutrient for plants, animals and human. Primary eruptive stones are found as pyrite (Fe_2S) and copper, nickel sulphides. Sedimentary stones or materials include anhydrite ($CaSO_4$) or gypsum ($CaSO_4.2H_2O$). In salt soils, what is the alkali and magnesium sulfate compound. The soil reaches some amount of sulfur from the atmosphere. SO_2 gas in the air goes down in the rain (Kantarcı, 2000; Boşgelmez et al., 2001; Özbek et al., 2001; Gardiner & Miller, 2008).

Micro Nutrients:

Iron is an essential element for plants, animals and humans. A small amount is needed by all living things (Özbek et al., 2001). Most of the iron in the soil is found as the building element in the crystal lattices of various minerals. Ferrous silicate minerals such as olivine, augite, hornblende and biotite are primary minerals containing iron. Iron in some parts of the clay minerals, in the form of oxide, hydroxide, carbonate and phosphate in many soils (Kantarcı, 2000; Boşgelmez et al., 2001; Güzel et al., 2004).

Chlorine sources are NaCl, KCl and MgCl2 minerals which are formed by apatite Ca_5 (F, Cl) $(PO_4)_3$ and sodalite (Na4Al3Si3O12Cl) minerals. It is a plant nutrient that is not found in nature freely. It is mostly found in the form of mineral chlorides with sodium chloride (NaCl). Magnesium chloride and potassium chloride are found in seawater and in some beds (Kantarcı, 2000; Boşgelmez et al., 2001).

Copper chlorophyll production is a plant nutrient required by the plant for respiratory and protein synthesis. Activation of various oxidase enzymes and the transfer of a large number of electrons are carried out by copper. It is effective in protein and carbohydrate metabolism. It has a role in fixation of symbiotic nitrogen (Boşgelmez et al., 2001; Gardiner ve Miller, 2008; McCauley et al., 2009).

Manganese is in the structure of various primary and secondary minerals. Primary source is silicate minerals. Olivine gabbros and micaschists and serpentines are more common. In the soil, manganese has 3 and 4 valent manganese oxides with power dissolving. The solubility of manganese in soil varies according to soil reaction, microorganism activities and soil water characteristics (Kantarcı, 2000; Boşgelmez et al., 2001).

Zinc silicate minerals in the soil, as oxides; It is contained in clay minerals or in organic matter. In magmatites, metamorphics and mineral deposits as zinc sulphide (ZnS, sphalerite) and with some other heavy metals, they are present as sulphides. The zinc in the soil is transformed into insoluble compounds over time. Insoluble binding of zinc increases at high pH. In contrast, the solubility of zinc compounds increases as the soil simplifies (Kantarcı, 2000; Özbek et al., 2001).

Molybdenum is particularly present in primary minerals. Molybdenum, wulfenite, powellite and ferromolybdenum are among these. Olivine and biotite minerals are also rich in molybdenum. Keeping in the soil is similar to the retention of phosphate anions. Iron and aluminum oxides also retained by. (Kantarcı, 2000; Özbek et al., 2001; Kacar & Katkat, 2010).

Boron is the only nonmetal element between the micro elements. Borax, kernite, colemanite, ulexite, ludvigit and katoit are other important boron minerals found in soils. Boron silicate minerals are mostly found in limestones and dolomites. On the other hand, the amount of boron in marine sediments is very high. The boron element is present in the soil as borates of (Foth, 1984; Kantarcı, 2000; Güzel et al., 2004; Gardiner & Miller, 2008; Kacar & Katkat, 2010).

It was revealed that the *nickel* element was a nutrient needed for the growth and development of the plant (Brown et al., 1987; Brown et al., 1990; Fageria, 2009). In general, the amount of nickel in the soil is very low. However, high amounts of serpentines are present in soils. The nickel leaking from the soil goes away from the soil with leaking water. In the arid regions, nickel in the soil cannot be washed and accumulates (Kantarcı, 2000).

The Effect of pH Level on the Plants in Waste Sludge:

- Acid Soils Calcium and Magnesium elements which are essential for plants are not sufficient. Therefore, plants growing in acid soils cannot get enough calcium and magnesium. Yield and Quality ability of these plants showing unhealthy structure is decreasing.

- Plants in acid soils give the battle of life. Acid Soils are unsuitable habitats for many plants. In this land, there is a war between plant and acidity. However, in this war, soil acidity prevails by damaging the plants, especially the capillary root system. As a result, the yield and quality of the crop decrease significantly. Strong acidity, especially in summer plants where dry farming is done, for example in sunflower plants, even the plant can prevent the exit. Despite the acidity, the plants on the soil to survive on the battle of life to enter into a significant loss of their ability to lose.

- Nitrogen, Phosphorus and Potassium are the macro nutrients and plants need to take these foods at the rates specified in Soil Analysis Reports. However, if the soil is acid, all of these foods contained in fertilizers cannot be taken by plants. Depending on the degree of acidity, they bind to the soil in significant amounts.

- The water-holding capabilities of the beach-based acid soils are low. If the soil is low in water retention, yield and quality will decrease. (Küçükaslan 2012).

The Effect of Salinity on the Plants:

The salty soils are soils that are commonly present in arid regions and contain soluble salts in an amount that will prevent plant growth. Soluble salts can easily be taken up by plants. It is harmful to the plant when it exceeds a certain concentration according to the type and amount of salt compounds entering the plant. The salt concentration in salinity or soil is determined by the electrical conductivity of the saturated solution (extract, solution). The electrical conductivity of a solution is proportionally dependent on its salt content (Karaman et al., 2007).

Salt stress in plants;

- Stunting in,
- Decrease in root growth
- Reduction of bud formation,
- Leaves and fruits remain small
- Fertilization disorders
- Causes the formation of yellow spots (necrosis) on the roots, buds, leaf edges and growth ends as a result of dying of cells (Yang et al., 1990).

The Effect of Heavy Metal Presence on the Plants in Waste Sludge:

Lead contains a variety of lead in various plants. Natural lead levels in plants are below 5 ppm. Natural lead time may increase according to the soil and the atmosphere in which the plant is grown. Most of the lead taken by the plant accumulates in the roots of the plant. Lead is not found in parts of the soil above the plant. The fact that the plant is taking or assimilating the lead is at a level of 0.05-5ppm of soluble lead in the soil rather than the total lead in the soil. Very soluble lead compounds are converted into lead compounds which cannot be dissolved in soil (Özkan, 2009).

The effect of *copper* on plants and living things depends on the chemical form and the size of the organism. It is a basic building component for large living beings while it is a poisonous property for small and simple living creatures. Therefore, copper and its compounds are widely used as fungicides, biocides, antibacterial agents and insect pests against agricultural pests and molluscs. Copper deficiency is observed in mineral soils, especially in sandy and pebbly soils. Copper is found in many foods and mostly in organ meat, shellfish, nuts and seeds. Wheat bran and whole grain products are also a good source of copper (Seven, 2018).

Total *zinc* in the soil is generally between 10-300 mg / kg and 30-50 mg / kg on average. Some acidic soils with high levels of washing contain zinc at levels as low as 10-30 mg / kg. Zinc is only toxic at high concentrations (Kaçağıl, 2013). Zinc-soluble forms of zinc are suitable for plants and the uptake of zinc increases as the concentration of the substance in the soil increases. Zinc intake depends on the type of plant as well as the environment. In particular, the amount of calcium in the environment affects zinc uptake. Zinc is usually found in plant roots (Okcu et al., 2009).

Cadmium is the element with the highest solubility in heavy metals. For this reason, it differs rapidly in nature and is not necessary for human life. Due to its water soluble properties, it is taken into the biological systems by plant and sea creatures as Cd^{2+} and has the property of being present. Cadmium fertilizers and pesticides are also easily found in the soil. Liver, mushrooms, shellfish, mussels, cocoa powder and seaweed (Özkan, 2009).

Plants are absorbed by *nickel* absorbing, ecological cycle of vegetables and fruits from the body of living creatures nickel intake is high. Nickel when exposed to contaminated soil or water (Özkan 2009).

The solubility in the form of *mercury* phosphate, carbonate and sulfate is immobilized in the soil to form low forms. Immobilized and water-insoluble mercury compounds are inaccessible to plants. However, these compounds can be reduced again to metallic mercury. The evaporation and environmental movement of the mercury may thus be possible (Okcu et. al., 2009).

Iron counts among the minor elements, but ranks fourth among the most common elements in the earth's crust. Plants are taken by small amount. Iron is necessary for the formation of chlorophyll. In the case of iron deficiency, chlorophyll does not form well and chlorosis is seen in plants. In case of iron deficiency, the leaves of the plants become light yellow. This situation is especially more pronounced in young leaves. The leaf veins are dark colored, but the veins are light. Iron chlorosis can be prevented by giving ferrisulfate (Fe_2SO_4) to leaves or directly to soil. In calcareous soils it is useless to give iron sulphate to soil. Sprayed into the leaves of plants (Özkan, 2009).

The permissible total Cr level in *chromium* agricultural soils is 100 mg / kg and the extractable Cr level is around 1 mg / kg. Soils composed of serpentine are rich in Cr. The increase in Cr content in plants is not seen much. In most soils, Cr has not been found to have a harmful effect even in the case of the use of Cr salts with high water solubility due to the immobility of Cr. The movement of chromium within the plant is also very limited. In contrast, Cr, which is applied at very high levels, can have toxic effects on plants. Plant roots in chrome poisoning is small, leaves are narrow and brown red color. Leaves are composed of small burn spots (Karaçağıl 2013).

Use of Treatment Sludges in Agricultural Areas

Waste sludge from sewage treatment plants contain high amounts of nutrients, so their use in agriculture minimizes the use of fertilizers. It is important that there is no toxic material in the waste sludge. Because it does not benefit the land by pouring the substances not found in the environment into agricultural land, damage to the soil structure can be given.

The periods in which the sludge will be deposited to the soil vary according to the climatic conditions of the region, the plant production program and the permissible load. The most important factor in the calculation of the load that can be given to the soil is the maximum amount of mud that the soil can absorb without causing floods and ponding. İkinci önemli faktör, azot ve fosfor gibi besin maddeleridir (Nisanoğlu, 1998).

It is necessary to pay attention to the amount of nitrogen in the waste sludge given to the land. Excessive application rate may cause damage to crops as it prevents seed germination and growth. Ammonia in waste sludge, preventing seed germination. Bunu engellemek için tohum atılmadan birkaç gün önce çamur toprağa püskürtülmelidir ya da arıtma çamuru havalandırılmalıdır (Filibeli, 1996).

The ability of the soil to use mud depends on the physical and chemical properties of the soil. Soil must be capable of filtering, buffering and absorbing sludge as well as product growth. Generally, the soil be treated with mud should be medium permable (1,5-15 cm/ha), good drainage, neutral or alkaline to control the solubility of heavy metal, must have fine to provide high moisture and nütrient capacity (Filibeli,1996).

RESULTS

It is known that the amount of wastewater increases with the increase of population. Used wastewater must be treated in treatment plants in order not to harm the nature and to be reused in certain conditions. At the end of the treatment process, the amount of waste sludge from the plant is increasing. In order to use the waste sludge in agriculture, investigations should be done in detail. Waste sludge from industrial water treatment is not preferred in agricultural land because it can contain heavy metal heavy metals. Stabilized sludge from domestic wastewater is more suitable for farmland. These sludges are used for breeding in agricultural areas as a result of investigations, if they are suitable for salinity, nutrients, heavy metal and pH. The use of stabilized slurries also reduces the use of fertilizers. The fact that fertilizer is rich in ammonia can cause problems during the sprouting of plants. Stabilized mud is also suitable for plants because it is rich in nutrients.

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