Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

EFFECTS OF LAND APPLICATION OF MUNICIPAL SOLID SEWAGE SLUDGE AND WASTE PLANT COMPOST ON WHEAT GROWTH AND SOIL ENZYMATIC ACTIVITIES

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With rapidly growing industrialization and urbanization, nowadays nations face countless problems; one of them is declining soil fertility. In this study we aimed to improve soil fertility and biological activity by adding organic amendments, which includes municipal solid sewage sludge (MSSS) and waste plant compost (WPC). Inappropriate utilization of organic matter can impact negatively on soil fertility and plant growth. A pot experiment study was conducted to investigate the potential of 6 weeks of consecutive application of municipal solid sewage sludge and waste plant compost response of wheat (Triticum durum) to different doses (0, 15, 30, and 45%: w/w) to restore brown forest soil functions. Plant growth, shoot biomasses and heights, ratios and chlorophyll content was considered. Soil fertility parameters including Soil pH, moisture content, total organic carbon, soil total nitrogen content and soil enzyme activities i.e. fluorescein diacetate, dehydrogenase, β-glucosidase, urease activity, and alkaline phosphatase as well as aryl-sulfatase were measured. Evaluating the results, it can be stated that organic waste has an improving effect on the enzymatic activities and plant growth parameters in all cases; therefore, it can be of great help to agriculture and crop production. It is shown that application of waste plant compost has more soil biological improvement than the municipal solid sewage sludge, with 15 and 30% organic waste.

***Keywords**: municipal solid sewage sludge, waste plant compost, wheat growth, soil enzymatic activities*

INTRODUCTION

Today, to face the quick increases in the global population due to the low education and influencing of the lifestyle, for example, unhealthy social life and bad economic conditions and unprotected environment conditions, and reduction on the agricultural areas and foot-staff production. These problems come up on a global scale as part of the global environmental problems which are caused due to, for example, the effects of climatic changes (i.e., the emissions of greenhouse gases) and environmental pollution. Now, we have to work on reducing environmental pollution (e.g., soil pollution) and improving the soil quality and crop production, and not least but also reducing the rate of organic waste disposal materials.

To come to this point, according to the recent studies, which show that by applying organic waste disposal materials in the field of agriculture as raw organic matter increases soil fertility and quality after the biodegradation processes carried out by the soil microbial activities. These microbial contents in soil are able to release the degradable enzymes to break down the complex organic matter to simple one or two carried out what is called mineralization.

Accordingly, the biogeochemical cycles can give the correct answer on soil microbiotas' ability to increase soil quality and crop productivity. During these studies, it is clear that the most critical tool in the process of biodegradation is the enzyme. Due to the beneficial impacts of soil biological properties, it is crucial to investigate the effect of waste organic matters on enzymatic production through enzymatic activity. This is the main point of the whole research. So, it is decided to do the thesis on the effects of different organic waste materials on the production and activities of some essential enzymes that play a role in soil improvement.

Organic soil amendment

The amendments for the soil are basically a substance whose purpose is to change the soil's properties more willingly than for plant fertilizers. For example, soil with lots of clay or sand texture, benefits from the organic materials by improving its quality. Organic matter rich soils preserve water or moist more and hold up many nutrients. Most soil additions are made up of no-cost or low-cost materials including locally accessible manure and compost, home-grown compost, pine bark fines, leaves, grass clippings, cover crops, and food leftovers. Compost and manure products double as fertilizers with a guaranteed nutritional analysis, and soil amendments provide certain plant nutrients.

Common soil amendments and sources

Agricultural and food wastes, animal manure, grass clippings, and leaves are used to make commercial composts. Many commercial types of compost follow a composting protocol and regularly evaluate for content, quality, and pollutants. Pesticide residues in commercial compost pose very little harm [5]. Herbicides are only present for a brief time in soil and compost, and they seldom cause problems. Producers and sellers should test their composts on a regular basis and be ready to give test results. However, manure and commercial compost have been polluted with a few long-residual herbicides (aminopyralid and clopyralid) in recent years.

Urban sewage sludge

Rapid industrialization and population growth has resulted to the higher amount of municipal sewage sludge production day by day. It is one of the primary problems for any part of the world that how it could be disposed and its use in this massive volume of sewage sludge. There are many ways that it could be solved as beneficial by product, which include burning, landfill disposal or even using it as soil amendments in the landfills. It is known that municipal sewage sludge is very dense and rich in nutrient organic substance, which has lots of variable plant supporting or promoting components, including nitrogen, phosphorus and potassium fertilizers and micronutrients such as magnesium, calcium and sulfur. By encouraging microbial activity, recycling plant nutrients and enhancing the soils physicochemical qualities, sewage sludge can increase the soil health. For example, components in the sewage sludge can also promote the water retention, ion exchange and soil aeration. The main benefit of using sewage sludge as fertilizers in the agriculture is that it may replace the chemical fertilizers, with economically sustainable [1].

Nonetheless, applying the sewage sludge in the landfill might become hazardous for the environment due to its excessive chemicals and heavy metal contamination. Some negative changes in agricultural soil caused by sewage sludge additives, dependent on soil type, physicochemical features of communal sewage sludge, its rate and repetition of application. The high amount of heavy metal contamination might pollute the soil and affect plant development and soil microbiology. Therefore, the considering the effects of sewage sludge application is essential for the microbiota of soil and its properties.

Benefit of organic soil amendments

Using inorganic fertilizers for some time could bring to negative environmental impacts. It could lead to bigger problems like biodiversity loss in the soil, oxygen depletion, and in the worst case desertification. Hence, it is crucial to find a better solution for the sustainable management for reduction of environmental harmfulness.

Throughout the years researcher have been developing solutions to decrease the negative environmental impacts on horticulture, which to name a few are crop rotation, soil organic treatments and legume cultivation. Nevertheless, with the increasing population and food demand, chemical amendments have been established in a broad area [1].

Soil organic amendments could benefit in both increasing food demand and balancing sustainable healthy soil. In the previous studies, it has been proposed that consequence of the organic fertilizer is dependent on the soil characteristics, previous frequency of fertilization, type of the plant and the timing [2].

Soil enzyme activity and their shift after organic soil amendment

Soil microorganisms are primarily responsible for soil ecological processes. Enzymes are classified in the biology as transferases, hydrolases, oxidoreductases, lyases, ligases and isomerases. But mainly the enzymes go to hydrolases, but for the reason that of its location, it could be classified differently. Many factors affect the enzymatic activity, but mostly it depends on the presence or absence of the inhibitor and activator. Also the reaction of it is temperature reliant. Soil enzymes perform various functions. The ß-glucosidase supplies the microorganisms with energy in the form of glucose. The phosphatase helps break down phosphorus; the urease and the amidase provide ammonium. The sulfatase converts sulfur into plant-available sulfate. The higher the corresponding nutrient concentrations in the soil, the lower the enzyme activity is often; this is clearest with phosphatase and urease, less so with sulfatase. The urease activity on grassland is twice as high as under peas and ten times as high as conventional N fertilization. The ß-glucosidase is 80% higher under a red fescue-clover than under an all-grass stand. However, there are also indications that the P content does not influence the phosphatase activity in the soil. If the initial phosphate bioavailability is high, there seems to be a positive correlation with phosphatase activity.

MATERIALS AND METHODS

Soil Origin

In this research work, the soil was collected from the garden of Rejto Sandor Faculty of Light industry and Environmental Engineering, Óbuda University. The garden is located to the west of the faculty building and the soil is Ramann's brown forest soil, which was not been exposed to any chemical or other agricultural treatments before. Its geographical coordinate of the soil pick-up point was Latitude (Y) 47°31"59.46"N and Longitude (X) 19°1'57.53"E as in shown Figure 1.

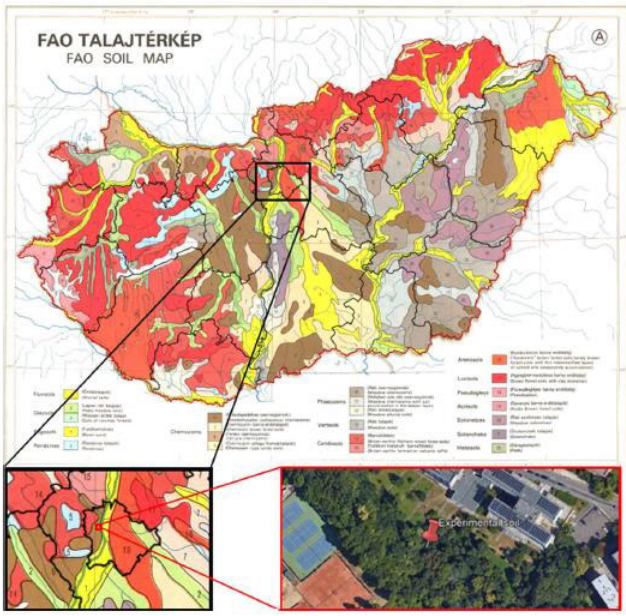


Figure 1. Collection point of the soil sample on soil map [3]

Using a garden shovel and plastic bag, around four kilograms of soil were taken from the topsoil, particularly from the depth of 0-25 cm. The collected soil was transferred to the laboratory and air dried for some weeks to remove excess moisture.

Plant residues, stones, and other debris or big particles were taken off by hand. A ≤ 2mm standard stainless-steel sieve was used for five minutes to homogenize the soil. Later, it was sent to Institute of Soil Science Centre for Agricultural Research, to measure some physicochemical characteristics of the soil. The results are shown in Table 1.

Table 1. Physicochemical characteristics of the tested soil

Tested parameters	Measurement units	Values
pH_{KCl}	-	7.13
EC	µS/cm	32.34
$CaCO_3$	m/m %	3.34
H	m/m %	1930
Total Nitrogen Content	mg/kg	18.76
NH_4-N	mg/kg	73.69
AL-P_2O_5	mg/kg	51.7
AL-K_2O	mg/kg	169
Al-Na	mg/kg	37.2
KCl-Mg	mg/kg	146
KCl-S	mg/kg	14.1

Communal sewage sludge

The wastewater sewage sludge was obtained from the Nyiregyhaza wastewater treatment plant, which processes communal sewage through aerobic digestion reactors. The domestic wastewater treatment plant sludge was transferred to the laboratory and stored in a refrigerator at 4°C. Its physicochemical characteristics were later examined as shown in Table 2.

Table 2. Physicochemical characteristics of municipal sewage sludge at Nyiregyhaza

Tested parameters	Measurement units	Values
pH_{KCl}	-	6.71
Dry matter content	%	53
Organic matter	%	21.7
Humus content	%	-
Total Nitrogen Content	mg/kg	7470
NO_3-N	mg/kg	-
NH_4-N	mg/kg	-
Mg	mg/kg	2507
Na	mg/kg	994
P_2O_5	mg/kg	28720
K_2O	mg/kg	3171
Zn	mg/kg	537
Cu	mg/kg	110.4
Mn	mg/kg	421
Fe	mg/kg	11308
Cd	mg/kg	2.3
Pb	mg/kg	66.9

APPLIED METHODS

The homogenized air-dried soil was carefully mixed with the compost from agricultural waste and domestic wastewater sewage sludge. The final mixture was containing organic amendments in the following percentages by weight: 0% (control), 15, 30, and 45%. The soil amendments and their replications are shown in Table 3.

Table 3. Soil organic amendments and replications

	Control	Sludge amendment			Compost amendment		
	0%	15%	30%	45%	15%	30%	45%
Replication 1	×	×	×	×	×	×	×
Replication 2	×	×	×	×	×	×	×
Replication 3	×	×	×	×	×	×	×
Overall	3	3	3	3	3	3	3
		9			9		

According to the above plan, recycled plastic cups were each filled with 250±5 grams of soil, and each cup was planted with seven wheat (common wheat: *Triticum aestivum* L.) seed. Every seed had minimum 1 cm distance from each other and the wheat seed was preliminarily selected based in their size, which are not less than 7 mm in length and not less than 4 mm in width (Figure 3). The seed was grown at 25±2℃ for 28 days. The exact amount of water was given to the plants every two days to maintain the soil moisture at approximately 45%.

Figure 2. Planting the wheat after mixing with the compost and wastewater sludge

Soil pH and moisture content

The pH of control soil as well as both communal sewage sludge and compost amended soils were measured by using the method of Perez De Mora et al. [4]. After 28 days of incubation, the pH of both untreated and treated soils was examined after 60 minutes of shaking with the ratio of 1: 2.5g/ml-1. By modifying the procedure of Brzenzinska et al., [5] the moisture content of the amended and non-amended soils was calculated. Originally the technique was to use an incubation temperature of 105℃, which will make the process faster; however, it was dried at 28℃, to be more cautious. The chosen heat was also close to the natural conditions, so that would be easier to determine the complete dryness in the outside environment.

Total Organic Carbon

The total organic carbon in the treated and untreated soil was examined using the method of Walkley and Black et al., [6]. Briefly, it was evaluated by dichromate oxidation and titration with the addition of ferric ammonium sulfate, so that the organic matter in the sample is consumed upon potassium dichromate oxidation. One gram of soil weighed to the 500 ml Erlenmeyer flask, where 10 ml of 1N potassium dichromate solution and additional 20 ml of sulfuric acid was added later. Approximately all the components were slowly rotated for 60 seconds, by cautiously not leaving soil particles on the inside wall of the flask. After settling for 30 minutes, 0.2 grams of ammonium fluoride, 10 ml of phosphoric acid and exact 10 drops of diphenylamine indicator were poured into the previous mixture. 0.5 M ferrous ammonium sulfate solution was used as titrant until the colour turned from dull green to blue.

Total Nitrogen Content

The total nitrogen content of soil was determined by using the Kjeldahl apparatus as defined by Keeney and Nelson et al., [7] based on the Kjeldahl method. The nitrogen will react with concentrated sulfuric acid in the presence of copper (Cu^{2+}) salt as catalyst to increase the boiling point and increasing reaction rate as shown below:

$H_2SO_4 \rightarrow SO_2\uparrow$

$C, O \rightarrow CO_2\uparrow$

$H, O \rightarrow H_2O\uparrow$

$N \rightarrow (NH_4)_2SO_4$

Before basification, the diluted sulfuric acid and ammonium sulfate solution was neutralized with concentrated sodium hydroxide mixture. With the help of a strong base, it displaces ammonia from ammonium sulfate, where it can be easily removed from the solution by heating or boiling.

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_4OH$

$2NH_4OH \rightarrow 2NH_3 + 2H_2O$

Organic N + $H_2SO_4 \rightarrow (NH_4)_2SO_4 + H_2O + CO_2$ + other constituents from the sample

Measurement of plant growth and plant dry matter

The growth of the plants was measured at the conclusion of the experiment, after incubating wheat seeds were modified and non-amended soils. Root length and stem heights were measured. To measure root length, small plastic cups were removed, and soil was gently shaken away. Roots are floated in sufficient amount of water in acrylic trays. This allows the roots to be arranged to reduce overlap and crossing of roots. Metal forceps and plastic pipette tips were used as instruments. Both root and stem height were measured with an ordinary ruler and measurement unit was centimeters. Relative dry matter content (%) compare to control plants was examined only on stem similarly to the detection of soil dry matter. It was dried until constant weight in an oven at 75℃ for around 10-12 minutes.

Chlorophyll intensity

During the experiment, the chlorophyll content of the leaves was determined by using the Walker et al., [8] method. All the samples were acetone extracted before measuring with spectrophotometer. The absorbance was measured with different wavelength: 647, 652 and 664 nm. The equations used for chlorophyll content calculations were:

Chlorophyll a (mM) = 13.19 X A664 – 2.57 X A647

Chlorophyll a (mM) = 22.10 X A647 – 5.26 X A664

Total chlorophyll (mM) = 7.93 X A664 – 19.53 X A647

Chlorophyll intensity expressed as acetone extracted: mg chlorophyll g-1 fresh weight.

INVESTIGATION OF ENZYMATIC ACTIVITIES IN SOILS

Dehydrogenase activity:

To measure the dehydrogenase activities in treated and non-treated soils, the method by Wolinska et al., [9] was followed. The procedure started with mixing six grams of soil with 0.12 grams of calcium carbonate and after four millimeters of distilled water and one millimeter of a 3.5% concentrated 2.3.5.-triphenyl tetrazolium chloride solutions were poured. The mixture was slowly mixed by rotating for 60 seconds, where later individually every sample was extracted with 25 milliliters of ethanol for precisely 60 minutes in the dark environment. Afterward, each sample was incubated for 20 hours at the temperature of 30℃ and then filtrated. Finally, with a wavelength of 485 nanometers, the absorbance of the soil extracts was measured. During the procedure, the dehydrogenase activity, and micrograms of generated triphenyl formazan per gram of soil were employed.

Catalase activity:
The method written in Feigl et al. [10], was used to detect the CAT activity in amended soils. In the experiment, two grams of soil were mixed with 40 milliliters of distilled water and 5 milliliters of 0.3% hydrogen peroxide. The soil suspensions were incubated for twenty minutes; it was filtrated one by one. Following to removal of the hydrogen peroxide from the sample, each suspension was titrated with 0.02M potassium permanganate. It was calculated by the reaction amount of permanganate in each dry soil weight.

Fluorescein diacetate hydrolysis:
For measuring the fluorescein diacetate hydrolysis, the modified method by Schnürer and Rosswall [11], which was firstly created by Zelles et al. [12] was used. A spectrophotometer at a wavelength of 490 nanometers was used for the detection.
Urease activity: The measurement of urease activity (µmol NH4 + -N g-1 dry soil h-1) was done in accordance with, the method of Nannipieri et al., [13].

Phosphatase activity:
Phosphatase activity (µmol p-nitrophenol (PNP) g-1 dry soil h-1) was measured according to Tabatabai and Bremner et al., [14].

Beta-glucosidase activity:
β-glucosidase activity (µmol p-nitrophenol (PNP) g-1 dry soil h-1) was detected by the procedure which is declared by Masciandaro et al., [15].
Arylsulfatase activity: The activity of arylsulfatase (µmol p-nitrophenol (PNP) g-1 dry soil h-1) was measured by a method developed by Tabatabai and Bremner [16]. After the incubation of the soil with PNP sulfate, absorption of p-phenol was measured at 400 nanometers.

STATISTICAL ANALYSIS

As stated before, three duplicates in triplicate were used in the research work, which is placed in a randomized block design. To calculate the statistically significant differences between treatments, a correlation based on a single classification was implemented. The standard deviation in each value was calculated at $P < 0.05$.

RESULTS AND DISCUSSIONS

Soil pH and moisture content
Soil pH is an important parameter, which plays an essential part in the nutrient availability of the plants. Based on their pH value, soils are classified as acidic, neutral, and alkaline soils. As mentioned before, the soil used in this research was assigned a soil based on its pH value of 7.13. The soil pH value before and after organic amendments was comparable, but there was a slight change in its pH value. So, therefore, it difference was not significant. It was found that by adding the organic matter (the wastewater sludge or the compost material) to the soil, the moisture content in each amendment was increased. This increase in soil moisture content was significant differences from the control (the untreated sample). Also, by increasing the application rates of organic matter the moisture content increase. Also, statistically, it was found that there are differences between the application of wastewater treatment and the application of compost to the brown forest soil. The increase of the soil quality and consequently facilitating plant growth is the main importance of the soil organic amendment, wherein this study, the collected topsoil was amended with 15, 30, and 45% of wastewater sludge and compost from agricultural waste. The moisture content of the organic amendments at different concentrations was measured in comparison to non-amended experimental soil (control). From Figure 3, it could be seen that the time required drying a constant weight increased in correlation with an increased amount of organic share. For instance, non-amended soil reached complete dryness after ten hours, while 45% compost amendment soil required far more prolonged time, i.e., twenty-five hours to reach constant weight to complete dryness. Wastewater

sewage sludge amendments always presented shorter time duration than sludge amendments to become completely dry. It reflects the theory that the increased organic matter content leads to increased moisture retention both in compost and sewage sludge. It could be also clearly noted that the proportion of the variable had a strong relationship.

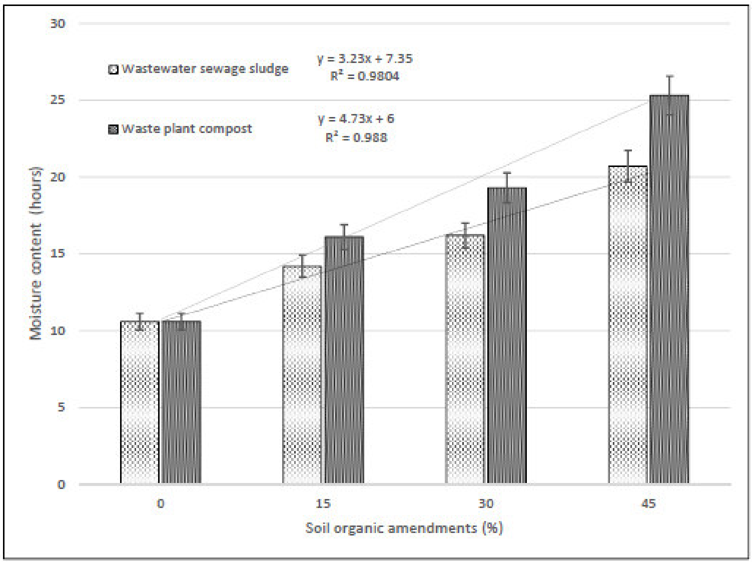
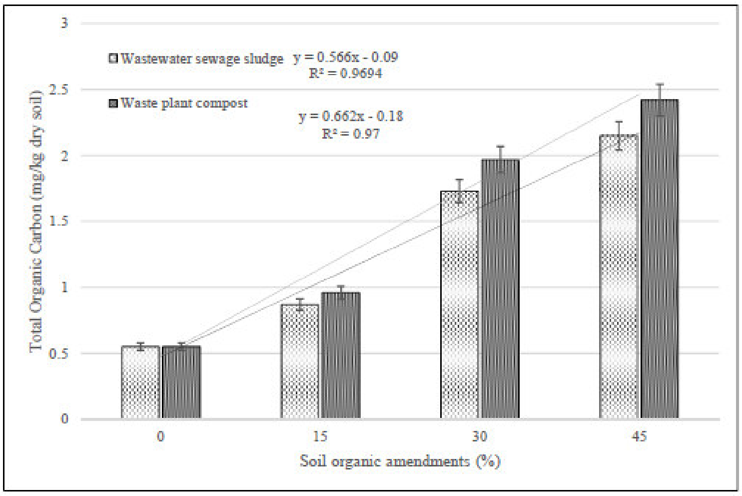


Figure 3. Moisture content (%) at different concentrations of organic amendments

Total Organic Carbon

Therefore, there were no significant differences between the two amended soils at a 15% application rate, compost amended soil had always a higher amount of organic carbon. From the coefficient of determination, it could be stated that the values are not significantly high or low at some point. However, as shown in Figure 4, both 30% and 45% of treated soils significantly differed between the amended soils. The results could indicate that starting from the treatment 15%, the organic carbon in soil was rapidly increasing. Compared to the control soil the organic amendments are without doubt highly affecting positively,



Total Nitrogen Content

The results of TNC (Figure 5) were continuously increasing along with the rising amendment rates, which are shown in both wastewater sewage sludge and compost from agricultural waste. There was significant difference at all treated soils, although plant compost had always a higher amount than sludge. The coefficient of determination was close to 1, which means the variable was accurate as predicted.

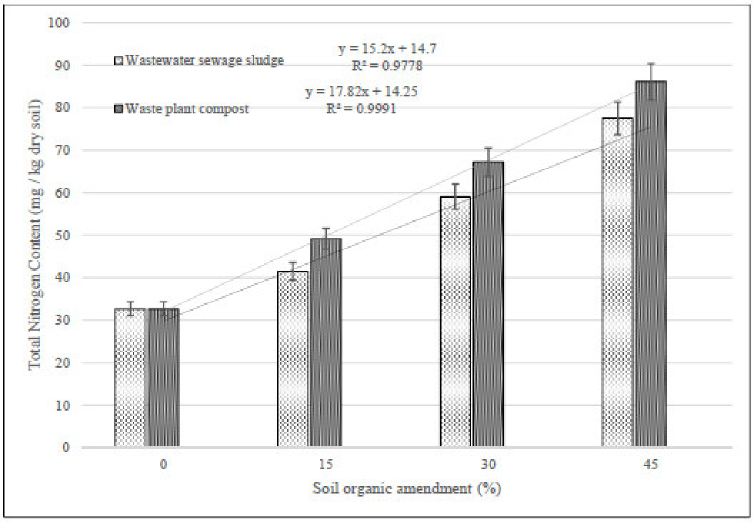


Figure 5. Total nitrogen content (TNC: mg/kg dry soil) at different concentrations of organic amendments

ENZYMATIC ACTIVITIES

Dehydrogenase activity

For the result of dehydrogenase activity (Figure 6), there was a significant discrepancy at all rates, excluding the control soil. It was most effective at 30%. Although the dehydrogenase activity in the highest amended soils had decreased drastically, waste plant compost had always higher value than the other amendment.

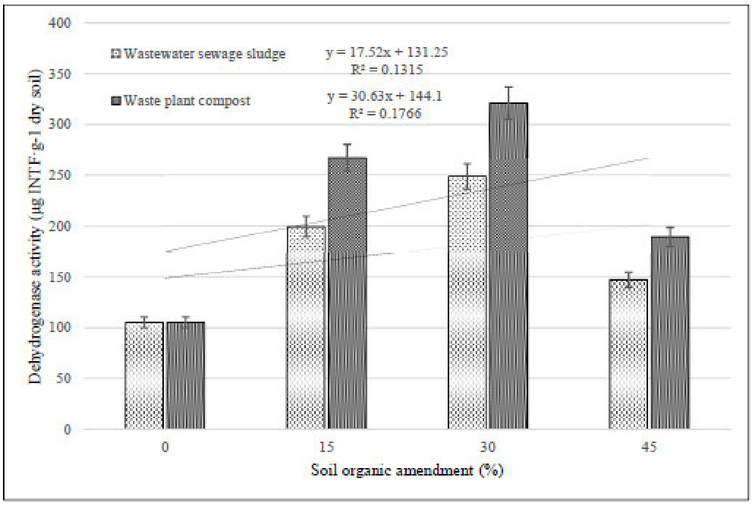


Figure 6. Dehydrogenase activity (μg INTF·g-1 dry soil) at different concentrations of organic amendments

Catalase activity

Unlike the other enzyme activity (Figure 7) results, catalase activity remained elevated with the increasing amount of organic amendments, especially with 45% of sludge and compost amendments. There was no significant difference between the two amendments. Treating soil with organic amendment helped the expanded catalase activity very effectively.

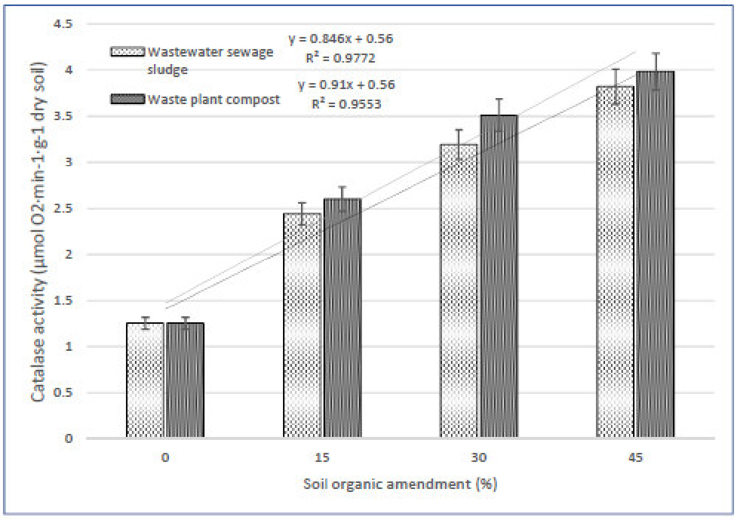


Figure 7. Catalase activity (µmol O2·min-1·g-1 dry soil) at different concentrations of organic amendments

Fluorescein Diacetate

The end result of Fluorescein diacetate activity was very similar to the dehydrogenase activity, in which the results were elevated with 15% and 30% amendments and then significantly decreased with 45% amendment, especially in the case of sludge amendment. Figure (8) shows, that there is a significant difference in all the treated soils, but compost treated soil was lower than the other one, only at the rate 45%.

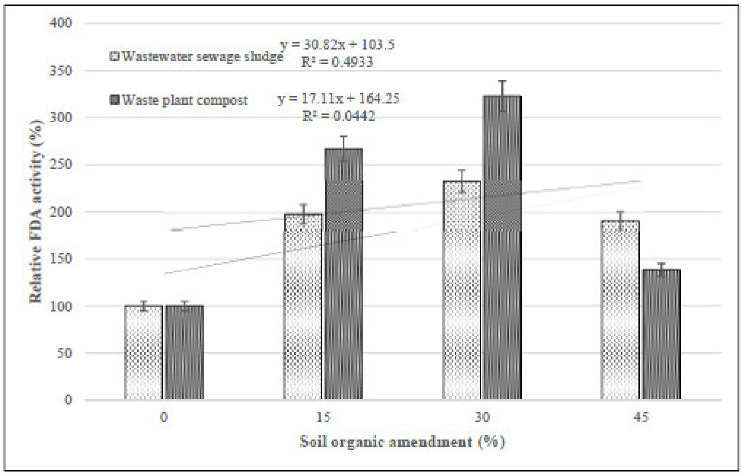


Figure 8. Relative fluorescein diacetate (FDA) activity (%) at different concentrations of organic amendments

B-glucosidase activity

From the data in Figure 9, it can be seen that B-glucosidase activity was increasing with a minor significance at 15% and 30%, whereas a high amount of significance was detected at 30%. At 30%, the compost amended soil had far better activity than the sewage sludge amended soil, although it fell remarkably at 45%.

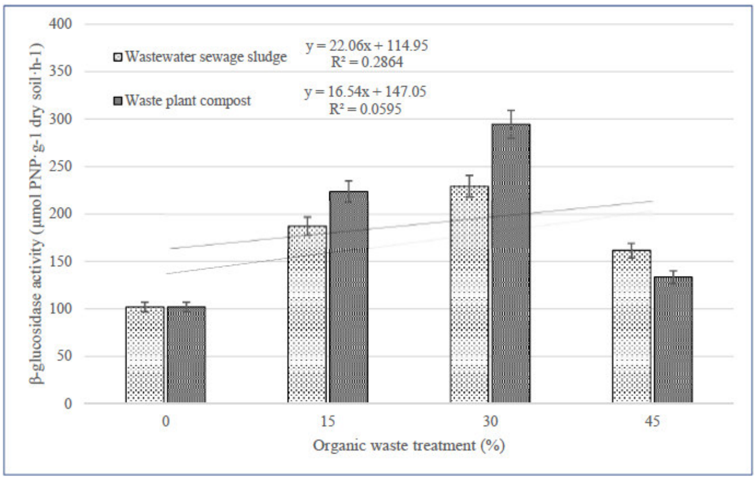


Figure 9. B-glucosidase activity (µmol PNP·g-1 dry soil·h-1) at different concentrations of organic amendments

Urease activity

From the bar chart (Figure 10), it can be seen that at 15% the results were slightly increasing, but at the 30%, it increased rapidly compared to the 15% amended soil. There was no significant difference between treated and untreated soil at 30%. At 45% the plant compost had a lower value than sewage sludge and the gap between the values was significant.

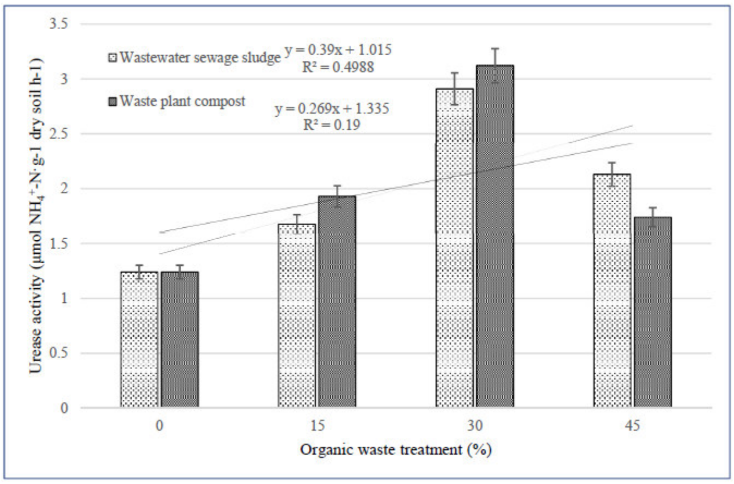


Figure 10. Urease activity (µmol NH4+-N·g-1 dry soil h-1) at different concentrations of organic amendments

Alkaline phosphatase

Figure 11 indicates that at 15%, both treated soils had a high amount of alkaline phosphate activity, which is not much lower than the double concentrated (30%) soil. But as same as the other enzyme results, it declined.

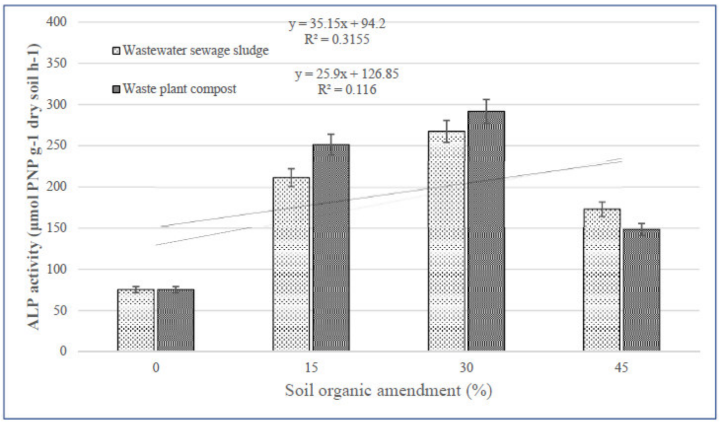


Figure 11. Alkaline phosphatase activity (µmol PNP g-1 dry soil h-1) at different concentrations of organic amendments

Aryl sulfatase

The results in Figure 12 show same tendency of reaction such as it was found in the activity of alkaline phosphatase, meanwhile at the amendment at 15%, the results had visible significant difference. At 15 and 30% the activities were in a high amount, until the results of 45% amended soil got equal as one half of the 30%.

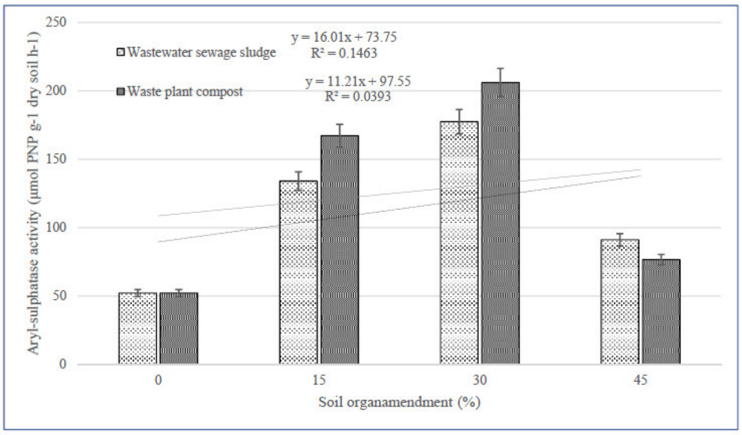


Figure 12. The degree of aryl-sulfatase activity (µmol PNP g-1 dry soil h-1) at different concentrations of organic amendments

PLANT PARAMETERS

Figure 13 shows wheat growth after twenty-eight days, where all of the seeds have successfully grown without any issue. The root length was measured after the measurement of stem height.

Figure 13. Wheat growth after four weeks

Root length

The Figure 14 shows that root length was longer with the elevated concentration of compost and sewage sludge till 30% and it became shorter at 45% amendments. These results were consistent with soil enzyme activities. According to the chart, at the concentration 15%, the significance between the two amendments was noticeable, but it was almost equal at the highest amendment 45%. The factors affecting negatively on root length could be explained, that the amount of organic substances were too high.

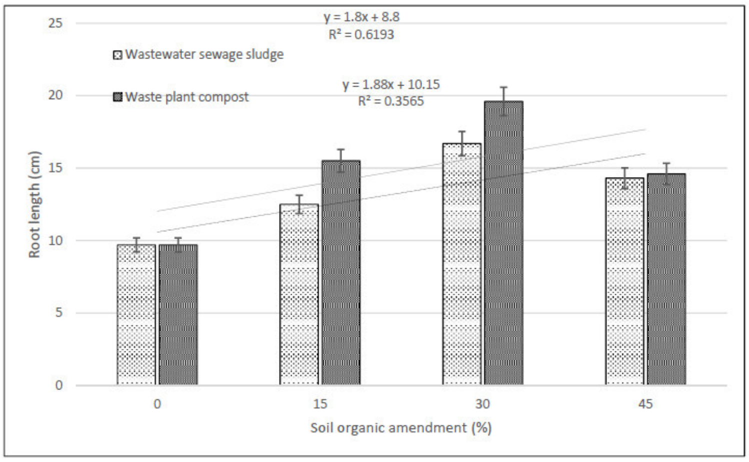


Figure 14. Root length of the wheat plant at different concentrations of compost and sludge amendments

Stem height

Little different than root length, stem height at the amendment 45%, did not fall drastically. There was no significant difference between the two treated soils, except at the highest concentration. It could be seen at the 45% amended soils; wastewater sewage sludge had declined tremendously compared to the 30% sludge amended soil, but not the same fall was seen for compost amended soil (Figure 15).

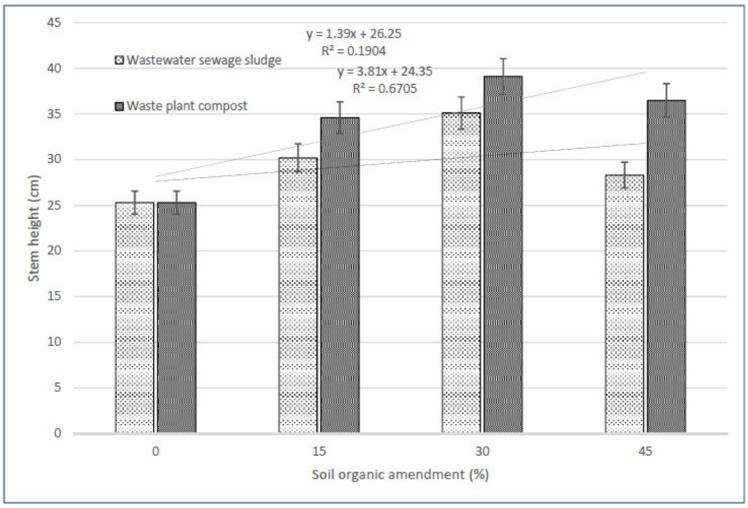


Figure 15. Root length of the wheat plant at different concentrations of organic amendments

Relative dry matter

The value of relative dry matter (Figure 16) of the wheat was pretty much the same as the enzyme and plant growth findings, where there was no significant difference between the communal sewage sludge treated and compost treated soils with the same concentration

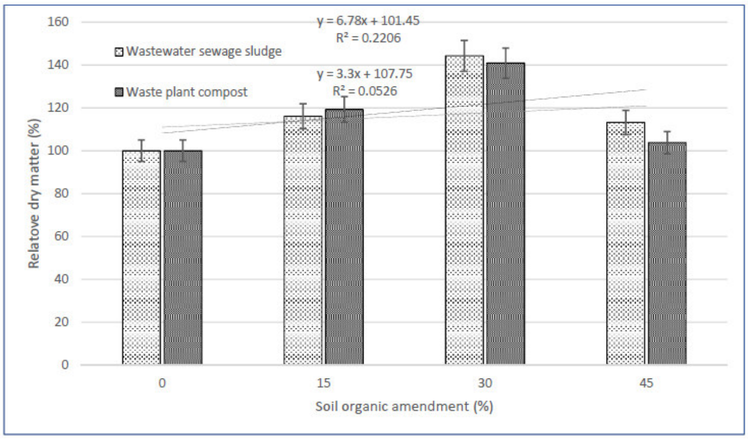


Figure 16. Relative dry matter (%) of wheat plant at different concentrations of organic amendments

Chlorophyll content

The result in the Figure 17 shows now significant difference in all rates between the both treated soils. However, communal wastewater sludge had higher amounts at 30 and 45%. The results are lowered at the highest concentration, which almost had the same value as the 15%. It was sudden that the result of the waste plant compost declined at 30%, thus both amendment was almost the same in 45%. The result was close to the dry matter of the plant, which might be explained that they are affected by same thing.

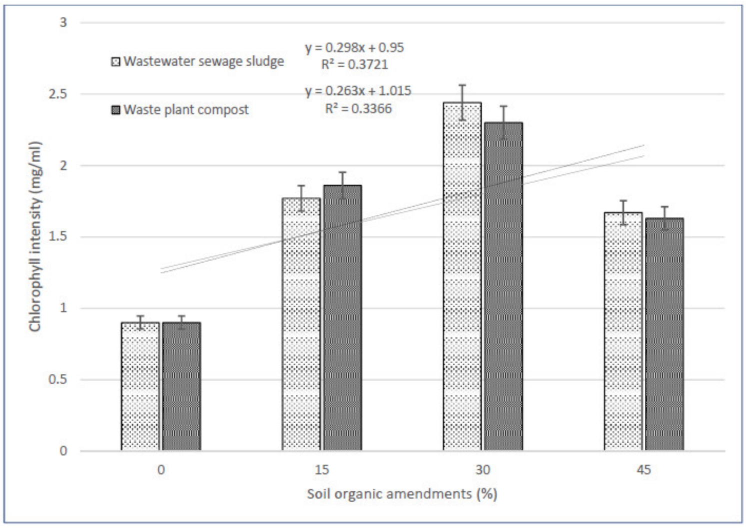


Figure **17.** Chlorophyll content (mg/ml) of green shoot of the wheat plant at different concentrations of organic amendments

CONCLUSION AND FURTHER TASKS

It could be countless to name the beneficial effects of microfauna on biological processing. The chosen two kinds of soil organic amendments: municipal sewage sludge and compost from agricultural waste, can affect the soil and its properties by promoting changes in its physical, chemical, and biological characteristics. In the present studies, it was implemented that two parallel amendments of communal sewage sludge and garden waste compost were at the rate of 15 and 30%, which improved the soil fertility and nutrients. The result showed that dehydrogenase and catalase activities tend to be higher with the amended soil than the non-amended (control) soil. A high concentration of applied sewage sludge and compost indicated a toxic effect on both soil microbiomes and plant growth. From these results, it could be suggested that the biological activities of soil are only moderately, however favourable affected by the organic amendments. A low amount of application in the landfill of municipal sewage sludge and compost could be environmentally friendly and sustainable management for economics. Because low doses of additives seem to provide macronutrients, and not have an excessive amount of heavy metal pollution. Generally, all these results persuade that sufficient soil organic amendments could lead to sustainable agriculture fertilizer. For further tasks, the municipal sewage sludge and compost from agricultural waste could be tested for different types of soil where agricultural activity can take place. For the experiment, only common wheat was used, however, in the further examination, variety of crop plants can be used to detect the enzymatic activities. Also, detecting broad area of soil characteristics could make it is easier to determine and compare the enzymatic results of sewage sludge and compost. It would be much more effective to take the experiment for a prolonged time, and take the soils from different seasons. Because in the previous studies, it was mentioned that environmental factors directly affect the enzymes in the soil. Municipal sewage sludge and compost from agricultural waste might be studied for various types of soil where agricultural activity can take place in future jobs. Only ordinary wheat was employed in the experiment; however, different crop plants can be used to detect enzymatic activity in the future. Furthermore, identifying a wide range of soil properties may allow determining and comparing the enzymatic outcomes of sewage sludge and compost more straightforward. It would be far more effective to carry out the experiment over a longer time and collect soil samples from several seasons.

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