IKR Publishers [International Knowledge and Research Publishers]

IKR Journal of Agriculture and Biosciences (IKRJAB)

Journal homepage: https://ikrpublishers.com/ikrjab/

Volume-1, Issue-1 (May-June) 2025

ISSN: XXXX-XXXX (Online)

The Effect of Compost Tea on Sandy Soil Characteristics

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ARTICLE INFO

Article history:

Received : 15-05-2025
Accepted : 22-05-2025
Available online : 27-05-2025

Keywords:

Compost tea, Pedo-features, Electron microscope.

ABSTRACT *Original research paper*

Compost tea is a natural raw material rich in organic matter, especially humic and fulvic acid. It also contains a high percentage of the nutrients needed to nourish the plant. Therefore, in this research, compost tea was used to reclaim sand soils that are poor in organic matter content and poor in chemical and physical properties. Add 60 ml/liter of compost tea to every 5 kg of sandy soil over the course of a year. The results showed the following:

Firstly, with regard to the chemical and physical changes, there was increased in the percentage of clay from 1.82 to 8.95 %, and also increased in the proportion of silt from 6.75 to 13.45%, respectively, and thus a change in the soil texture from sand to loamy sand. Also, there was a clear change in the cationic exchange capacity. It rose from 1.25Cmolkg-1 in the control to a mean of 5.34Cmolkg-1 and this has a direct impact on plant nutrition, holding and retaining nutrients and these pests are lacking in fertile soils. In addition, increasing in percentage of organic matter from 0.13 to 1.12%.

Secondly: The results obtained from the micro-morphological features study by electron microscope of the samples treated with compost tea confirmed that there are clear changed in the ground structure changed from grano-striated to poro-striated which Monic related distribution changed to locally Gefuric and Chitonic due to using compost tea. Large portions became covered with compost tea plates in the treated samples.

On the other side it is clear that numerous smooth vughs, vesicles and channels are observed as well as compound voids for packing void with sample treated compost tea. In addition, characteristic changes in the predominant voids from plain samples in sandy samples to complex packing as well as some coarse cavities and chambers in the soil treated with compost tea extract.

Introduction

Today, sandy lands have become one of the solutions to bridge the global food gap, but due to their shortage of fertility and poverty in organic matter content, and thus the lack of nutrients needed by the plant and the lack of yield. Therefore, researchers resort to apply organic fertilizers in their reclamation, as tea compost which is rich in content organic matter. In recent years, research has confirmed the benefits of using organic fertilizers, including compost tea, has many advantages compared to chemical fertilizers, so it is recommended by international agricultural organizations.

Firstly, the advantages of using compost tea with the chemical properties of sandy soil. It has been observed that it increases the cation exchange capacity, and in acidic soils, it reduces the rate of phosphorus fixation in the soils (Leifeld et al., 2002).

In addition, applying compost tea to the soil provides most of its nutrient and organic matter content (Carballo etal., 2008). Compost tea also provides sandy soil with the nutrients the plant needs (Nasef et al., 2009) also recorded that the compost tea reduce the pH of the soil as a result of its decomposition and the release of some organic acids from it, such as (amino acids, such as glycine and cysteine, as well as humic acid) and increasing the bacterial activity of microorganisms. Meanwhile, the soil salinity decreased by leaching as a result of improving the physical properties of the soil.

In saline soil conditions, biochar can be mixed with compost tea and magnetic iron ore. Amer (2016) found that applying these materials had a positive and economic impact on wheat and corn yields and soil characteristics. Siddiqui et al. (2011) added that increasing in major nutrients when applied the tea compost, and the percentage of increase depends on the rate of compost tea added. El-Galad et al. (2013)concluded that the addition of potassium humate and fertilizer increased micronutrients in the soil. El-Shaieny et al. (2022) mentioned that the practice of compost tea in agricultural leads to increase calcium carbonate and pH soil.

Secondly, the effect of compost tea on the physical properties of sandy soil.Christian et al. (2019) confirmed that the improvement in porosity, filtration and the structure of sandy soil with increased use of compost tea.

At present, numerous studies have emphasized the positive effect of tea compost on characteristics physical, chemical and biological activity of living organisms and increasing the organic matter content in sandy soil when applied the tea compost (Maria and Jorge 2016).

It is worth noting that compost tea plays an effective role in the characteristics chemical of sodium, which causes salinity in saline soils, as it led to its removal from the root zone around the plant, as confirmed by Day et al.(2019).Amer et al. (2021) added compost tea with gypsum by spraying on the leaves in rice cultivation, and an increase in rice productivity and an increase in the economic return resulting from saving a unit of water were observed. The ratio of soil infiltration and hydraulic conductivity, high significantly is due to the further improvement of the ground structure by increasing the aggregations in the sandy soil, and thus improving the ground porosity responsible for water conservation.

In this field, Amer (2016) studied the effect of a mixture of compost tea, magnetic iron, and biochar on some of the physical properties of sandy soil. He recorded a decrease in the apparent density values, and consequently a decrease in infiltration and an increase in the hydraulic conductivity values, which ultimately leads to improving the natural properties of the soil.Tandon (2000) found that using compost tea extract in salinity soil improved the physical characteristics such as total porosity and bulk density.

Thirdly, regarding the effect of compost tea on the biological activity of soil organisms, (NOSB, 2004) confirmed the positive effect of compost tea on biological of soil and fertility. Shrestha et al.(2011)stressed that the applying of extract compost tea in the soil increases the microbial communities beneficial to the soil, and this is due to the fact that the compost tea extract contains many beneficial enzymes, hormones and auxins. Edris et al. (2003) pointed out that compost tea increases the process of nitrogen mineralization from organic nitrogen, which becomes more available to the plant. Aulakh et al. (2000) and El-Gizawy et al. (2013) clearly demonstrated an increase in bean productivity and an improvement in the biological and chemical properties of the soil as a result of the use of compost tea and rice straw compost fertilizer. Mohamed et al (2016) concluded that compost tea mixed with mineral fertilizers achieves the best productivity with radish plants because it encourages bacterial activity and increases the absorption of nutrients. Radovich and Arancon (2011) referred to the improvement of the pH in saline soils and the reduction of salinity through biodiversity when using compost tea extract.

The objective of this research is to estimate the influence of compost tea on physical, chemical and morphological of sandy soil properties.

Materials and methods

The sand soil sample studied from Wadi El–Natrun, Egypt. The soil sample before putting in the pot were air dried and passed from 2 mm sieve. The studied soil sample treatment was re-irrigated with compost tea at rate 60 ml/L water per pot just weekly for a year.

Mechanical analysis was done according to Soil Conservation Service, (1984). Chemical analysis byBlack et al. (1982). **For micro-morphological features** observation four samples were prepared for thin sections (2 control and 2 with 60 ml/L compost tea application. Thin sectionswere examined by electron microscopy according to Bullock et al. (1984).

Results and discussion

Table (1) shows the results of laboratory analyses of characteristics physical and chemical of the soil studied. From the presented data, it was clear that the soil studied is sandy, no salinity, the content of calcium carbonate and cation exchange capacity are low and the soil is poor in content of organic matter. The soil is as Typic Torripsamment, according to Soil Survey Staff. (2003).

Table 1: characteristics physical and chemical of the soil studied

Soil Property	
Coarse sand% 2000:200u	7.05
Fine sand% 200:20u	84.38
Silt% 20-2u	6.75
Clay% > 2u	1.82
Texture	Sand
pH 1:5	8.54
EC dSm^{-1}	1.28
Organic matter %	0.13
CEC $Cmolkg^{-1}$	1.25
$CaCO_3$%	1.35

Table 2 demonstrations the chemical analysis of compost tea according to Brunner and Wasmer (1978).From the results of these analysis revealed that the compost tea is high rich in organic matter and this point will be the focus of this research.

Table 2: characteristics chemical of compost tea

EC dSm^{-1}	pH	C	O.M	N	P	K	Fe	Mn	Zn
		(%)					($mgkg^{-1}$)		
1.51	5.31	13	49	2.26	0.81	1.33	128	75	104

Table 3 shows the changes in some chemical and physical characteristics in the soil studied such as the textural soil, exchange capacity of the soil, pH, EC and organic matter content after mixing compost tea after one year.

Table 3: Soil properties after mixing with compost tea one year

Soil Property	
Coarse sand% 2000:200u	3.22
Fine sand% 200:20u	74.38
Silt% 20-2u	13.45
Clay% > 2u	8.95
Texture	Loamy sand
pH 1:5	8.11
EC dSm^{-1}	1.85
Organic matter %	1.12
CEC $Cmolkg^{-1}$	5.34
$CaCO_3$%	0.98

From the presented results, it is clear that there is an improvement in characteristics chemical and physical soil as a result of treating it with compost tea.

Analytical data show that there is a significant increase in clay content with the 60 ml/L of compost tea treatment, led to improvement the soil structure and this was confirmed by the morphological study in the same research. It is noteworthy that when added 60 ml/L of compost tea to the soil the clay content has increased from 1.82 to 8.95% and silt content increased from 6.75 to 13.45 respectively. These results are consistent with Suzuki et al. (2007) who explained the increase in the percentage of clay and silt in the surface layer(20cm) of sandy soil when adding organic matter. It is noteworthy that the pH values and calcium carbonate content were reduced compared to the control samples. This is due to the acidic effect of compost tea. Similarly, Guidi and Hall (1984) noticed that when using organic fertilizers, their decomposition results in some inorganic and inorganic acids, which in turn lower the pH of the soil. It is also noted that the values of cation exchange capacity and organic matter content increased in the samples treated with compost tea compared to the control samples. This is due to the richness of compost tea in humic and falvic acids.Tejada et al. (2006) and He et al. (1992) confirmed these results, as they found that the cation exchange capacity increased from 1.25$Cmolkg^{-1}$ to 5.34$Cmolkg^{-1}$when compost tea was added to the soil. This is considered the most important chemical

property of the soil. In addition, the organic matter content in control soil increased from 0.13 to 1.12%. These results are very important because increasing the CEC values leads to an increase in the sorption capacity and surface area and increasing in the soil fertility as a result of its permanent negative charge. This property gives the soil the ability to absorb and hold nutrients on its surface and supply it to plants when needed. Similar arguments are supported by Czaban et al. (2013) they stressed that the application of organic fertilizers in low-value soils increases the cationic exchange capacity. Amer et al. (2021) confirmed that in addition to increasing the cation exchange capacity as a result of adding compost tea, also the pH value and the exchangeable sodium ratio decreased, which leads to an improvement in soil properties.

Table (3) shows the salinity increased slightly after using compost tea for a year due to the higher salt content of the used compost tea than the soil of the experiment. However, the use of such compost tea for long period may cause an inconsiderable increase of the soluble salt content of the treated soil.

According to micro-morphological description of thin sections to the soil sandy samples treated with compost tea and untreated can be summarized the effect of compost tea on micro-morphological features of sand soil in the following:

Groundmass: Course grains (Skelton), mostly fine sand size, dominant coarse grains of mostly quartz micro and meso fine grains in the original soil without treatment compost tea (Photo 1, 3), moderately sorted euhedral and subhedral grains platy and blocky shapes sub rounded, angular smooth grades, moderately oriented. Dominant are minerals quartz.On the other handchanged from grano-striated to poro-striated due to using compost tea (photo 2) Large portions became covered with compost tea plates in the treated samples (photo 4).From the morphological description, it is clear that soil particles are aggregated with cementing materials resulting from the decomposition of organic matter present in compost tea. El-Gizawy et al. (2013) found that organic fertilizers addition such as compost tea improved the structure of the soil.

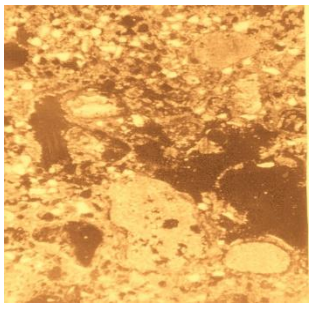

Photo1: Euhedral and Sub-euhedral coarse grains of quartz. Untreated PPL25X

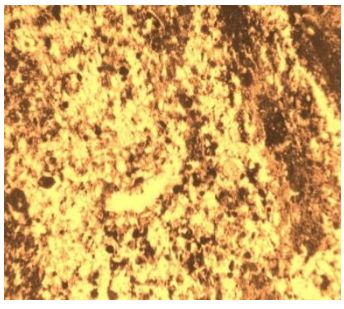

Photo2: Banded distribution pattern of compost tea. Soil treated.PPL25X

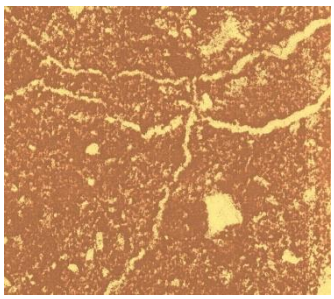

Photo3: Sharp large continuous planes. Soil untreated. XPL25X.

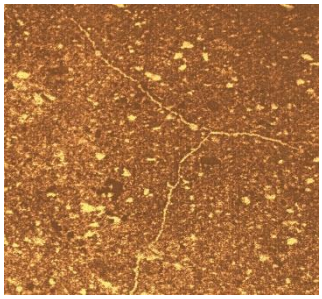

Photo4: Fine continuous planes. Soil treated with tea compost. XPL25X.

-Fine material (plasma), a part of the fine material in the ground mass mostly mixed with compost tea. In some cases these compounds are distributed in patches giving the appearance of mospic plasmic fabric or in lines as striated, masepic insepic types (photo 2).The groundmass in untreated sandy soil is commonly composed of coarse quartz granules.(Photo 1, 3), large portions became covered with compost tea bowls in the treated samples.

- C/F related distribution gives the ratio between the part occupied by the course (skeleton) and fine materials (plasma) respectively. Accordingly, Monic related distribution changed to locally Gefuric and Chitonic (photo 4).As a result of using compost tea for a long period in sandy soil, a relative increase in the clay content was observed compared to the sand (C/F).

- From the morphological description of the soil control, photo (3), and the soil mixed with compost tea, photo (4), it is clear that there is a clear improvement in the large voids and their transformation into narrow voids as a result of the particles joining together, and this increases the soil's ability to retain water and nutrients. The same results found by Amlinger et al. (2007).

Pedo-features: Voids, Chamber and vughs. It is indicated that in the type of voids, although they are not natural, they are mixed and preserved in columns. The predominant voids are mainly single and compound packing voids as well as in the untreated samples appears that some large irregular columns (photo 1 and 3). If manure tea is added and after twelve months of irrigation every 15 days, numerous smooth vughs, vesicles and channels are observed as well as compound voids for packing void (photo 2 and 4).Albiach et al., 2000 and Tejada et al., 2006 proved that compost tea has a positive role in improving the percentage of granule aggregation, thus improving the soil structure and increasing the soil's ability to retain moisture.

In particular, characteristic changes in the predominant voids from simple fine specimens in sandy to complex packing as well as some coarse cracks and chambers in compost tea processing specimens. Similar results were obtained by

Wahba and Darwish (2008). In some cases the compost tea is slowly and regularly deposited around a nucleic of coarse grain forming the concentric fabric, usually small is size and around in shape, such as pedo-features are usually called concretion(photo 2 and 4).On the other hand, it is noted that in photo(4) there is an increase in fine pores. This is due to the decrease in the apparent density of the soil, because the treated compost tea has a low specific weight, which leads to an improvement in the properties of the sandy soil (Brown and Cotton, 2011).

Photo 3 shows the sand grains are dominant, and therefore the pores and voids are wide, which allows the compost tea to fill those voids and becomes a cement material that welds the grains together photo 4.Wahba et al. (2020)confirmed the same results. The role tea compost helps the soil to retain water as a result of filling compost tea in large columns, voids, and, and chambers transforming from loose continuous to loose discontinuous (photo 2 and 4).

Another way in which the coarse granules can coalesce is coating the granules with compost tea, which contains organic and colloidal materials. These cementitious materials act as bonding materials that blocking large pores, thus changing the size of the pores from complex packing void to simple packing void photo (4).Many grains are coated with thin layer of compost tea external hypo-coatings (photo2). In other places thin film of compost tea complex around some skeleton grains. Some grains coated with layer of compost tea quasi coatings (photo4).Christian et al., 2019 proved that the soil porosity, soil infiltration rate, and aggregate stability increased with increasing of using the rate of tea compost. Consequently improvement the soil structure.
On the other hand, as a result of filling these voids and pores with colloids, the building turns from single grain structure to bridge grain structure and Pellicular grains structure (photo4) which is the main responsible for water retention and nutrient retention according to (Hassan and Abdel Wahab, 2013).

Conclusion

The research aims to reach a natural product for the reclamation of sand soils and that is not containing chemicals and pollutants harmful human and soil health. From discussing the results of the chemical and physical analysis and examining and studying the soil samples treated with compost tea using an electron microscope, it is clear that there is an improvement in the chemical and physical properties of the soil and the basic structure of the soil, and this was confirmed by the morphological description compared to the control samples. On the other hand, the best treatment in terms of its effectiveness and economy when applying compost tea at a rate of 60 ml per liter.

In addition the morphological study showed, the coarse granules in the soil untreated became covered with the humic and falvic organic acids and the ground structure is improved. As well as filling these voids and pores with colloids, the building turns from single grain structure to bridge grain structure and Pellicular grains structure and becomes a cement material that welds the grains together, which is the main responsible for water and nutrient retention. On the other hand, it was noticed an increase in the cationic exchange capacity, which is considered the main responsible for retaining nutrients and keeping them for plant needs.

In brief, the results and morphological studies confirmed on the suitability of compost tea as a natural conditioner for sandy soil reclamation. Furthermore, compost tea is generally considered environmentally friendly fertilizer.

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