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THE EFFECTS OF URBAN WASTE COMPOST ON PHYSICAL AND CHEMICAL SOIL PROPERTIES IN MOSTAGANEM REGION

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ABSTRACT

The sandy soils of the Mostaganem plateau (northwestern Algeria) are characterized by low organic matter concentration and are deemed unsuitable for agricultural cultivation. Organic matter or clay additives are recommended to improve their physicochemical and water properties. Many farmers in the Mostaganem region use a 20 t.ha^{-1} dose of urban compost made from wastes from a wholesale fruit and vegetable market by the CET technical landfill center in Oran. The goal of this study is to identify the best dose of this compost in an experimental setting on a plot of land in Mazagran's Mostaganem plateau. For the three treatments of 10, 15, and 20 t.ha^{-1} of compost and control without amendment, a complete random block device with three repetitions was employed. The following soil quality indicators were tested to compare the impacts of the three compost doses: pH, electrical conductivity, organic matter, total nitrogen, phosphorus, and potassium. The study's major findings demonstrate that the greatest outcomes for all soil quality indicators are obtained mostly at the dose of 15 t.ha^{-1}, with minor exceptions at the level of 10 t.ha^{-1}.

Keywords: Urban compost; sandy soil; soil quality indicators; physical and chemical properties.

Introduction

Soil is recognized as a crucial component in the terrestrial ecosystem; the physical and chemical properties of the soil are critical not only for food production for an ever-increasing population, but also for ecosystem services (Zhou *et al*., 2019). However, the features and quality of soil are impacted by expanding urbanization and its effects on human consumption patterns (El-Naggar *et al*., 2019). Contrarily, the development and widespread use of synthetic inorganic fertilizers have enabled farmers to sever the connection between organic soil additions and soil fertility (Scotti *et al*., 2015). Due to soil degradation, agricultural productivity, soil fertility, and quality have all decreased. Particulate structure, low water and mineral retention capacity, and reduced cation exchange capacity are all known characteristics of low-quality soils, such as sandy soils (Campos *et al*., 2020; Zhou *et al*., 2019; Imansk *et al*., 2019). They are vulnerable to water and wind erosion, and their nutrients are quickly leached (Campos *et al*., 2020; Domínguez *et al*., 2019).

Agriculture offers several management techniques, such crop rotation and the application of manure and compost, that may help lessen and guard against soil deterioration (Glab *et al*., 2020). Compost is commonly known as a type of organic amendment that improves the chemical, physical, and biological characteristics of soils (Glab *et al*., 2020 and 2018). Although the compost can provide vital plant nutrients, it is mostly fertilized with N, P and K (Bernal *et al*., 2017. It also raised total organic C (Domínguez *et al*., 2019), improved soil structure (Baldantoni *et al*., 2016), and boosted water-holding capacity (Benabderrahim *et al*., 2018), acting as a suppressant of soil-borne plant diseases (Wilson *et al*., 2018 and Neher *et al*., 2022). Compost increases the pH (Rupasinghe & Leelamanie, 2020), soil organic matter (Wilson *et al*., 2018), electrical conductivity (EC) (Rupasinghe & Leelamanie, 2020), cation exchange capacity (CEC), aggregate stability (Yüksel & Kavdır, 2020), and porosity (Domínguez *et al*., 2019). In order to lessen erosion from rain and runoff, compost can be used as surface mulch on slopes and bare ground (Stehouwer *et al*., 2022). Compost is viewed as an environmentally preferable alternative to peat as a soilless substrate or component of a growing medium (Bernal *et al*., 2017).

In comparison to chemical fertilization, urban composts offer an interesting alternative for improving the agronomic quality of sandy soils. Compost quality is determined by its content of organic matter (OM), nutrients, and contaminants (Brunetti *et al.*, 2019). With the anticipation of good effects on soil properties, as well as on the growth and yield of field crops, municipal solid waste compost can be successfully exploited for the field of agriculture in many regions throughout the world (Rupasinghe & Leelamanie, 2020). There are many ways to determine how much compost to apply to the soil, including considering criteria for organic matter, nutrients, cost of compost, and following local customs practiced Ozores-Hampton *et al.*, 2022).

The goal of this study is to see how three different compost doses affect the physico-chemical parameters of a sandy soil on the Mostaganem plateau.

Materials and methods

Materials

The experimental study was conducted at the farm of the University of Mostaganem. The plot is at Mazagran, with longitude 35° 53' 30.2" N and latitude 0° 5' 0.1" E as its geographical coordinates. Our experimental plot's soil is sandy, with 75.80 percent sand, 8.83 percent clay, and 15.37 percent silt (Table 1). It has a pH of about 6.5 and a porosity of 62.96 percent. The compost utilized has an organic matter (OM) level of 18.2%, a pH of 8.3, a C/N ratio of 10.37, and metal trace element values that are substantially below the criteria for compost use (Table 2) (AFNOR, 2006).

Methods

(i) Experimental device and application of compost

The experiment device was carried out in complete randomized blocks on 12 elementary plots, with four treatments and three repetitions. The assay covered a total area of 48 m^2. Each elementary plot was 4 m^2 (2 m x 2 m) in size, with a 1 m space between plots. The compost doses used were 10, 15, and 20 $t.ha^{-1}$ with the control plots remaining unaffected. The experimental plot was ploughed to a depth of 30 cm with a disc plough followed by the application of compost manually to the soil surface.

(ii) Methods of analysis

After oxidation of the organic matter (OM) with 5% H_2O_2 (Muggler *et al.*, 1997) and physical ultrasonic dispersion, particle size analysis was performed using a laser particle size meter. Dry combustion was used to evaluate total organic carbon (TOC) and total nitrogen (NT) using a Flash EA 1112 elemental analyzer (Thermo Finnigan). The organic matter content was estimated by multiplying the TOC value by the factor 1.724.

The available phosphorus was extracted using the method of Hedley *et al.* (1982) with some modifications (Condron *et al.*, 1985). The pH, Na, K, N, Al and Mg contents and electrical conductivity were determined according to the method described by Tedesco *et al.* (1995). The Siegrist cylinder method was used to determine the porosity and bulk density of the soil (Aubert, 1970). In each experimental plot, three soil samples were randomly taken at an average depth of 15 cm and mixed to obtain a single representative sample of the plot. The collected samples were sieved to 2 mm and dried at room temperature for analysis.

(iii) Statistical analysis

The results were statistically analyzed (ANOVA) by the HSD Tukey post-hoc test at $P < 0.05$.

Results and Discussion

When compared to the control, the pH readings do not appear to change as a result of increasing the compost dose (Figure 1). After 5 months, this progression has remained unchanged, although pH values did not increase significantly. Composting raises the pH of the soil solution somewhat, according to various researches (Rupasinghe and Leelamanie, 2020; Wilson *et al.*, 2018; Yang *et al.*, 2017). The degradation of organic compounds, which releases ions into the soil solution, could explain the rise in pH (Erana *et al.*, 2019). Electrical conductivity can be used to determine the salinity of soil or the total number of dissolved ions present in water (Benabderrahim *et al.*, 2018). The electrical conductivity data reveal that the 10 $t.ha^{-1}$ compost dose has no effect on it when compared to the control (Figure 1). However, it decreases by 44 and 18 percent for 15 and 20 $t.ha^{-1}$ compost dose, respectively. The EC shows a non-significant increase over time, after 5 months. These findings corroborate those of Erana *et al.* (2019), Benabderrahim *et al.* (2018), and Arthur *et al.* (2012). Due to the presence of charged sites (COO^-), which account for humic acid's capacity to chelate and retain cations in inactive forms, soil electrical conductivity values tended to decrease (Semida *et al.*, 2014). As a result of degradation by biotic and/or abiotic factors, organic matter is rapidly released into the atmosphere resulting in rapid loss of organic matter in the soil (Rupasinghe & Leelamanie, 2020). Compost amendment is considered as a fundamental technique to improve the physical characteristics of nearly all soils, typically soils with low structure and low quantities of OM (Kranz *et al.*, 2020). One technique to significantly enhance SOM is to apply composted organic amendments (Wilson *et al.*, 2018, Yang *et al.*, 2017).

Soil OM content increased by 23 and 8 percent for 15 and 20 $t.ha^{-1}$ compost dose, respectively, compared to the control (Figure 2). Although the differences are not significant, a comparison of the compost doses reveals that 15 Tha^{-1} is the best value. SOM content increases insignificantly after 5 months for all treatments. The studies of Yüksel and Kavdr (2020), Kranz *et al.* (2020), and Yang *et al.* (2017) suggest that compost application boosts soil OM. Other scientists have shown that increases in SOM as a result of compost intake were not substantial in the near term (Ouédraogo *et al.*, 2001). According to other research, soil organic matter, total nitrogen (N), and microbial activity increased three years after composting, indicating chemical and biological changes (Kowaljow *et al.*, 2017). This is most likely due to a high rate of carbon sequestration, which is especially high in sandy soils (Ouédraogo *et al.*, 2001). For doses of 10 and 20 $t.ha^{-1}$, the total nitrogen content of the soil increased non-significantly. Nonetheless, when compared to the control, the dose of 15 $t.ha^{-1}$ increased by 21.56 percent. After 5 months, the TN content shows a similar trend (Fig. 3). These findings are in agreement with those of Ouédraogo *et al.* (2001).

The phosphorus content accessible to the plant increased by 2, 6 and 9% at doses of 10, 15, and 20 $t.ha^{-1}$ of compost dose, respectively compared to the control (Fig. 3). Phosphorus is necessary for energy storage, root absorption, and crop maturity (Erana *et al.*, 2019; Hosseinpur *et al.*, 2012). Several publications claim that adding compost enhances the available phosphorus content (Leogrande *et al.*, 2020; Domnguez *et al.*, 2019; Murtaza *et al.*, 2019). Nonetheless, the increases in available phosphorus content obtained after 5 months are negligible, which is consistent with some studies that show that the effect of compost on phosphorus availability is dependent not only on the quality of the compost, but also on the physico-chemical properties of the soil, such as clay and OM content (Ouédraogo *et al.*, 2001; Cabrera *et al.*, 1989). Only the 20 $t.ha^{-1}$ dose of compost shows significant increases in potassium K concentration. As the dose of compost is increased, the potassium content exhibits higher and higher increases after 5 months. This data results was consistent with the findings of Cabrera *et al.* (1989) who observed large changes in potassium after compost applications.

According to several studies, changes in the chemical and biological features of the soil can only be detected three years after the application of compost. Carbon, total nitrogen, and soil microbial activity are all amplified for this purpose (Kowaljow *et al.*, 2017). There was no equivalency between the availability of N and P in composts and the availability of N and P in soil under these conditions. This shows that N and P are not readily available from compost and that the rate at which they are mobilized varies depending on the compost type and soil conditions (Duong *et al.*, 2012). Due of the close interaction of compost with organic matter, nutrients are likely to be released slowly. Compost is an excellent alternative to inorganic fertilizers since it has fewer losses due to leaching and volatilization (Murtaza *et al.*, 2019). Although some composting products are deficient in nutrients (N, P, K), their delayed release over time allows for more effective nutrient mobilization (Rupasinghe and Leelamanie, 2020; Wortman *et al.*, 2017). The treatment of compost has an effect on the CEC of the soil (Fig. 4), with the dose of 10 $t.ha^{-1}$ having the highest value of this indicator. After 5 months of compost decomposition, CEC variations follow a similar pattern (Wilson *et al.*, 2018; Arthur *et al.*, 2012). Since the CEC largely increases as organic additions degrade (Wilson *et al.*, 2018), we can demonstrate that changing the CEC can only be noticed over the long term as a result of continuing compost deterioration.

Conclusion

The findings of this study demonstrate that the regularly used dose 20 $t.ha^{-1}$ by farmers is overstated. Indeed, only potassium had a significant concentration for the compost dose 20 $t.ha^{-1}$ out of all the soil quality measures used. All other indicators point to 10 and 15 Tha^{-1} producing the best benefits. It's vital to realize that these findings apply to a sandy soil, implying that the amount of compost needed for other loamy and clay soils would be lower. These findings demonstrate that the compost tested can be a viable alternative to chemical fertilizers, not only in terms of cost, but also in terms of soil sustainability and the risk of nitrate contamination of groundwater. It remains to know how to add compost to the soil and how to adjust the dose to the physico-chemical properties of the soil.

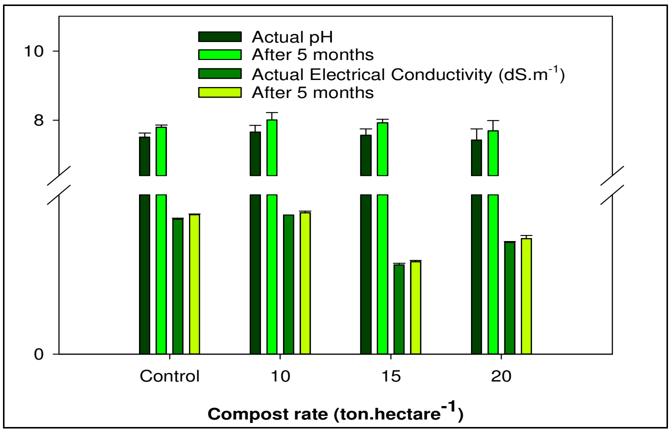

Fig. 1 : Effects of compost in pH and EC.

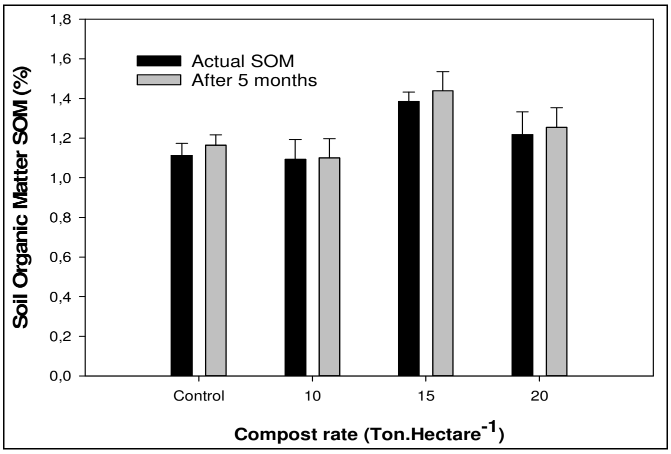

Fig. 2 : Effect of composts on organic matter

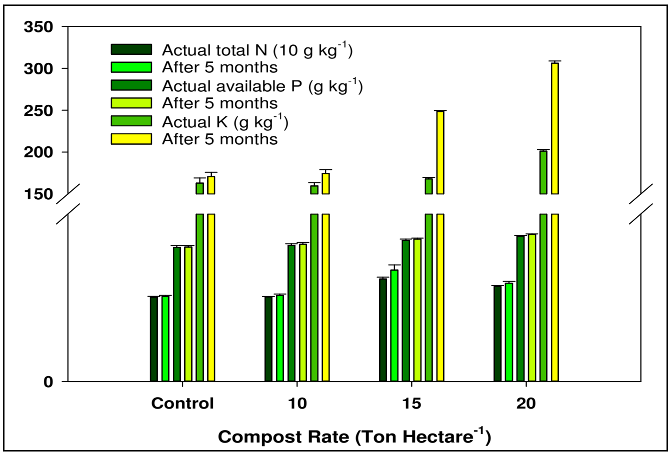

Fig. 3 : Effects of compost in the main nutrients (N, P, K)

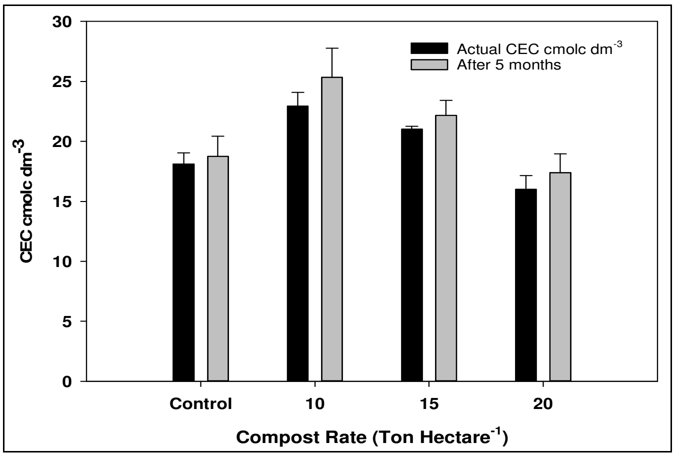

Fig. 4 : Compost effects on the cation exchange capacity (CEC) of the soil.

Table 1 : Physical characteristics of the soil

Indicator	Value
pH	7.54
Bulk density ($g.cm^{-3}$)	1.30
Porosity (%)	62.96
Sand (%)	75.80
Silent (%)	15.37
Clay (%)	8.83

Table 2 : Physico-chemical characteristics of compost.

Parameters		**Macronutrients**		**Metallic trace elements ($mg.kg^{-1}$)**	
Humidity	9.45	Total Nitrogen	0.96	Cd	<0.01
Dry Mater (%)	90.55	Total Phosphorus ($g.kg^{-1}$)	0.59	Hg	<0.01
Organic Mater	12.90	Total Potassium	2.68	Pb	<0.01
pH 1: 2.5(v/v)	8.35	Organic Carbon (%)	7.48	Cu	<0.01
C/N Ratio	7,79				

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