J. Mater. Environ. Sci. 2 (S1) (2011) 485-490 *Bouajila et al.*
ISSN : 2028-2508
CODEN: JMESCN
Colloque International « Journées des Géosciences de l'Environnement »
Oujda, 21, 22 et 23 Juin 2011 « Environnement et développement durable ».

Effects of organic amendments on soil physico-chemical and biological properties

K. Bouajila [1], M. Sanaa [1]
1. *Institut National Agronomique de Tunisie (INAT) Adresse: 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène, Tunisia*

Received Apr 2011, Revised 22 Dec 2011, Accepted 23 Dec 2011

Coresponding Author: Email: bouajilakhedija@yahoo.com; Tél: +21699418029

Abstract
The effects of three concentrations (40, 80 and 120 t/ha) of farm manure and compost made from household wastes on the chemical, physical and biological characteristics of soil with a long use history was evaluated. The results showed that both organic amendments type increased significantly (P<0.05) the organic carbon and nitrogen contents in a dose-dependant manner, with the effects being more pronounced for the compost made from household wastes. As a consequence of the increased organic matter in treated soils, a significant improvement in the structural stability, permeability and the CO_2 emission capacity was observed. These preliminary results showed the great potential of compost made from household wastes as organic and eco-friendly fertilizers and may be useful for the long-term management of the soil fertility.

Key words: organic amendments, solid wastes, organic carbon, organic nitrogen, carbon mineralization, soil quality

1. Introduction
During the past three decades, there has been increased awareness of soil degradation and its negative impact on its productivity. In Tunisian agro systems, the continuous tillage and the unsustainable soil management have contributed significantly to this problem. Such agricultural practices have led to progressive impoverishment in the organic matter contents in the A horizon and hence, a remarkable decrease of the initial productivity of these soils, derived from their unsuitable chemical properties. The organic matter content is a significant component and a key indicator of the quality of the soil. In fact, this parameter is directly related to different physical soil properties namely, bulk density, porosity, water infiltration and water holding capacity [1]. To circumvent the loss of the organic matter, amendment using solid wastes has been attempted. Of particular interest, manure and composts have received much interest and their positive impact on soil structure, stability, nitrogen and carbon content have been reported [2, 3, 4, 5, 6].
In Tunisia, despite the long history of land use and the continuous loss of the soil quality, there are no serious efforts to restore the soil quality and attempts in this direction are certainly missing. The present study was, therefore, intended to evaluate the influence of organic amendments (manure and household wastes composts) on some chemical, physical and biological properties of the soil.

2. Materials and methods

2.1. Experimental site and amendment assays

Experiments were undertaken in the experimental station of the National Institute of Agronomy of Tunis located in Mornag (Tunis, Tunisia). The soil used was silt-clayish, pH 8.1 with a few organic matters. Two non cultivated parcels were amended with increasing levels of manure and household wastes compost. For both treatments, 3 concentrations: 40, 80 and 120 t/ha were used and they are designated as M40, M80, M120 and C40, C80 and C120 for manure and household wastes compost, respectively.

2.2. Studied parameters

In this study, some parameters related to soil fertility were considered, i.e. organic matter performed by the method of Walkley and Black; and organic nitrogen contents performed by Kjeldhal's method. Other kinds of parameters were also studied, such as structural stability (method of benzene) and permeability (Darcy's law) in order to evaluate the treatments effect on the physical-chemical characteristics of the soil.

Analyses of inorganic carbon were performed by incubation using an oven (temperature: 28°C; RM (relative moisture) : 2/3 θ_{cc} during 34 days) aiming to study changes in the biological activity of the soil amended with increasing levels of the considered organic products.

2.5. Statistical analysis

For all parameters, difference between means were evaluated by one way analysis of variance (ANOVA) using Fisher ppds test (P<0.05). Statistical analyses were carried out using Statistix 7.0 software (2000) [7].

3. Results and discussion

3.1. Effects of organic amendments on the chemical characteristics of the soil.

3.1.1. Organic carbon and total nitrogen contents

The effects of organic amendments on organic and total nitrogen contents are depicted in figures 1 and 2. As can be seen, application of manure and household wastes compost resulted in significant (P<0.05) increase of both parameters, with the compost treatment being the most efficient. Our results showed that the application of 120 t/ha household wastes and manure improved an organic carbon (1.74 % and 1.09 %, respectively) when compared with control (0.69 %).

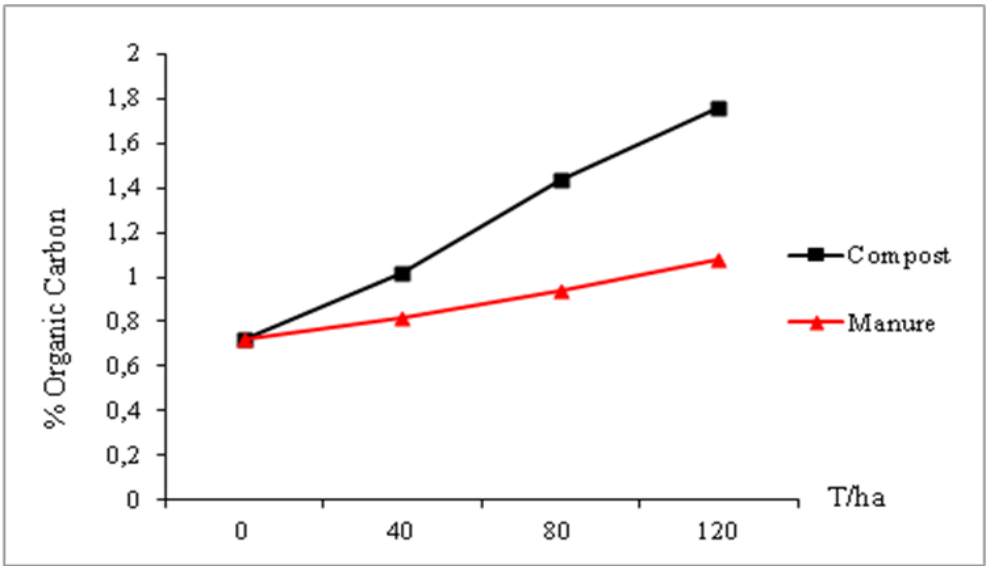

Figure 1. Variations in the organic carbon concentration (%) in amended parcels by compost and manure.

Meanwhile, the increase of both parameters seemed dose-dependant. These results are in good agreement with those of Meeuwissen (1992) [8] and Kaschl *and al.* (2002) [9] who found a positive correlation between the addition of compost and soil organic carbon contents. Glending and Powlson (1993) [10], Jedidi *et al*. (2004) [11] have reported that the application of increasing manure and waste household compost concentrations (40 and 120 t/ha) resulted in significant increase of organic nitrogen.

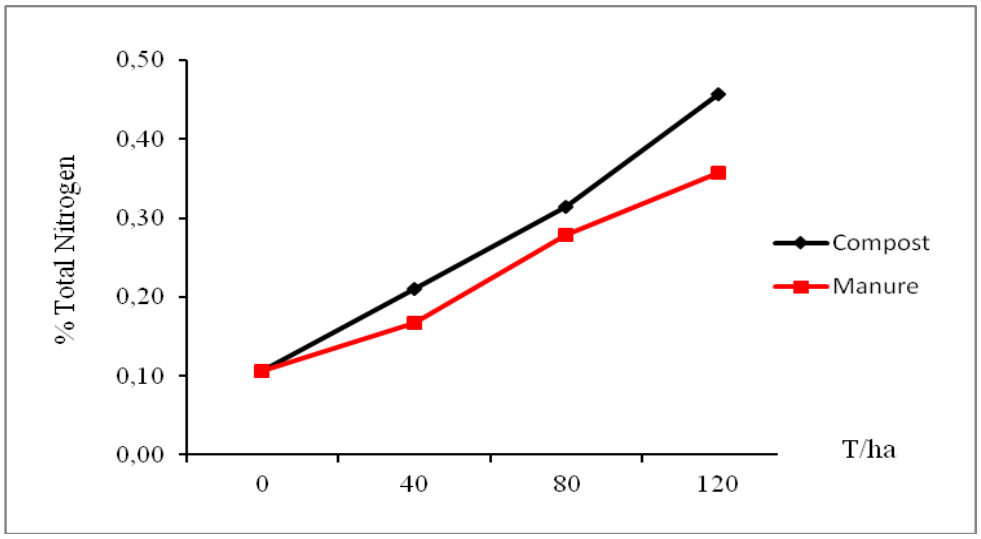

Figure 2. Variations in the total nitrogen percentage in soils amended with manure and compost

3. 2. Effects of organic amendments on the physical characteristics of the soil
3.2.1. Structural stability
As for chemical parameters, the addition of organic amendment was associated with a significant (P<0.05) improvement of the structural stability of the soil (Figure 3). Such behavior might be the result of elevated organic matter content and important microbial activities [12].

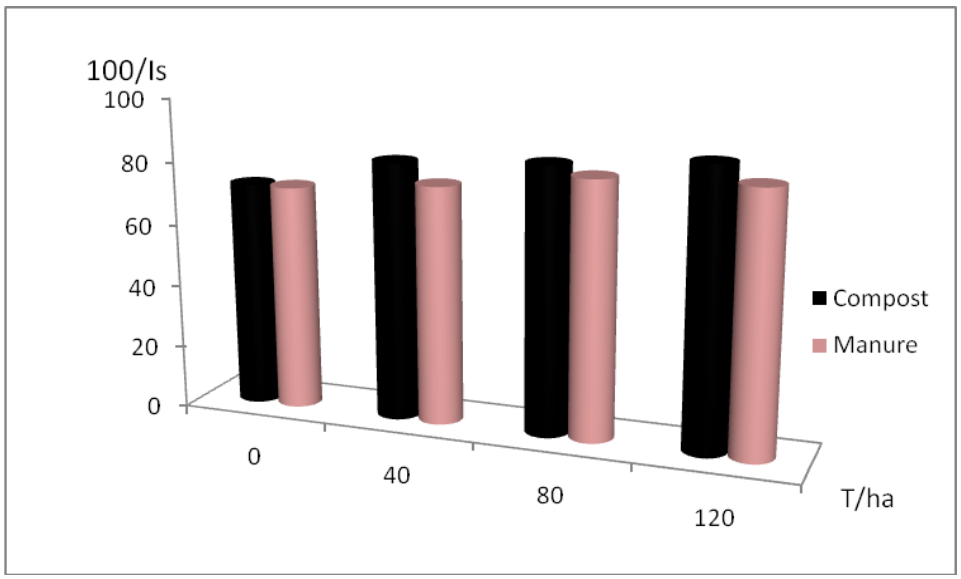

Figure 3. Changes in the structural stability in amended parcels with manure and compost

3.2.2. Permeability

In general, amendments allowed better water infiltration (Figure 4). Our results showed that the application of 120 t/ha household wastes and manure improved water infiltration (549.25 and 596.46 cm, respectively) when compared with control (332.16 cm). These results are often encountered in the literature, since water infiltration is essentially improved by the presence of organic matter and microbiological activity [13 - 14].

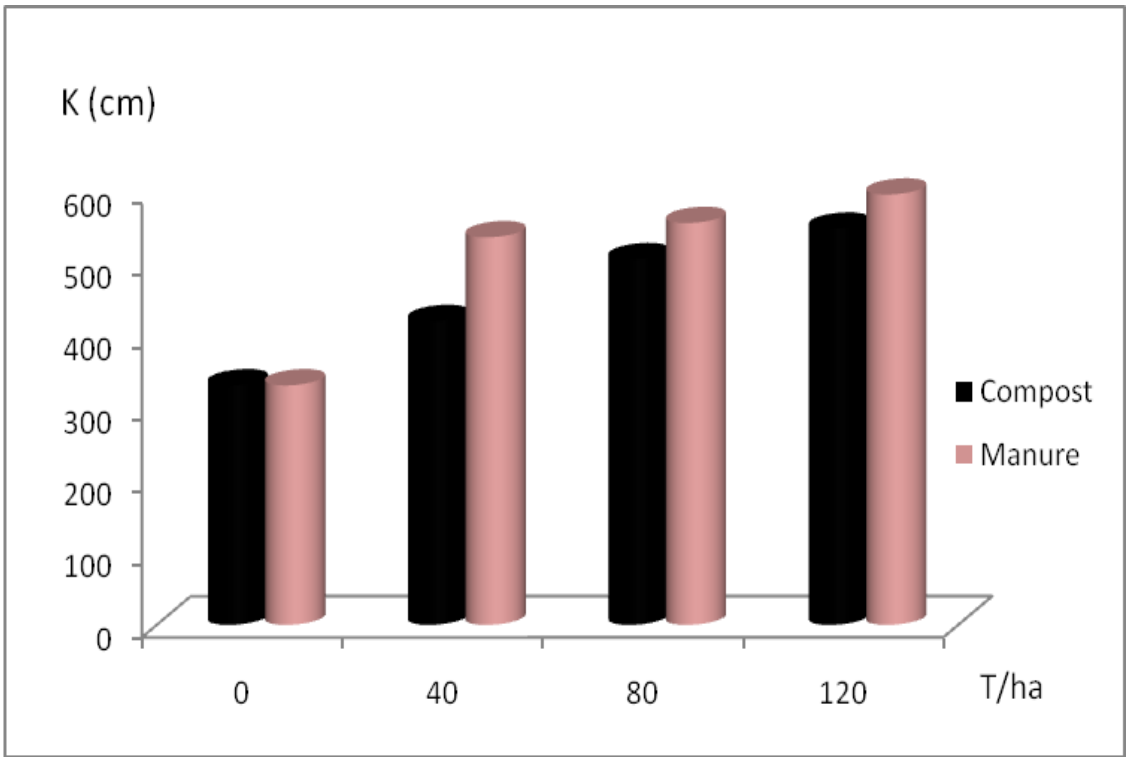

Figure 4. Variations in the permeability in amended soils with manure and compost

3.3. Effects of organic amendments on the biological characteristics of the soil

Evolutions of the mineralizing process expressed in mg/kg of emitted CO_2 showed similar trends for all soils (Figure 5). It consists in a line, showing that emission of CO_2 per day was relatively constant for all treatments during the period of incubation. However, rates were slightly more important in the amended soils with compost. Maximum CO_2 emitted was observed at the end of experiment following to the CO_2 accumulation. As for the chemical and physical parameters, the biological activitie was directly proportional to the applied dose of amendment.

The potential release of CO_2 shows variations between the control soil and soil amended with compost or manure, the value of higher is recorded for the soil amended with 120 T / ha of compost (35.8 mg CO_2 / kg).

Emissions of CO_2 were more important in the amended parcels with compost made of household wastes; suggesting that the organic matter coming from manure is less biodegradable probably due to their relative resistance to microorganism degradation.

The amounts of organic carbon mineralized at 28° C are similar to those observed by Annabi and *al.* (2005) [6].

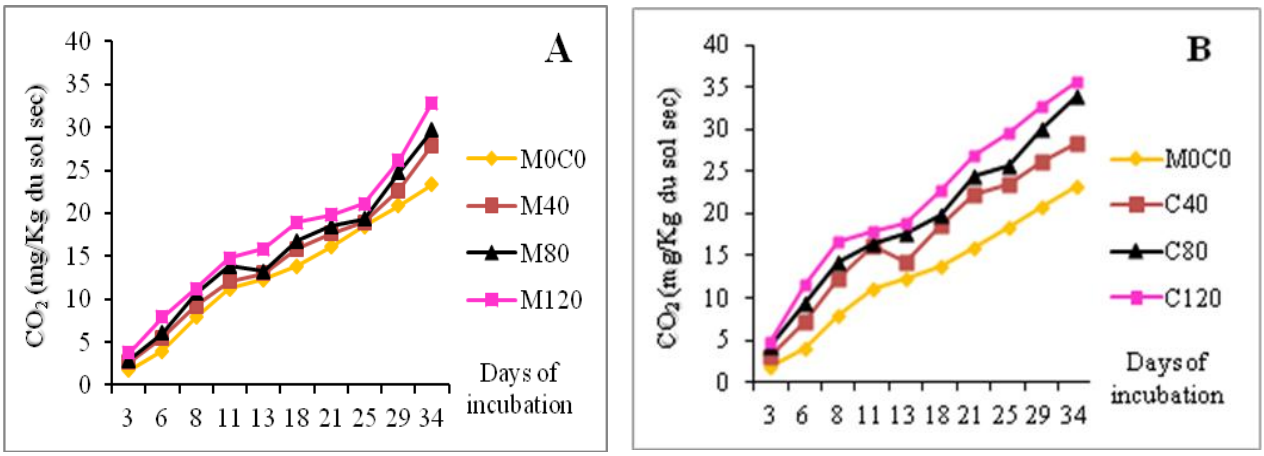

Figure 5. Variations in the daily quantities of emitted CO_2 (mg/kg) in amended parcels with manure (A) and compost (B). M0C0 (control soil) ; M40 (40 T/ha); M80(80 T/ha) ; M120(120 T/ha) of manure - C40(40 T/ha); C80(80 T/ha) ; C120 : 120 T/ha of compost.

Conclusion

Manure and household wastes are two types of organic amendments that can improve the physical, chemical and biological characteristics of the soils

Analysis of the organic amendments effect on the physical characteristics of the soil revealed a better structural stability when applying compost or manure. In addition, soil permeability was improved due to the presence of an appreciable amount of organic matter associated to an important microbiological activity.

Concerning the effects of organic amendments on the chemical characteristics of the soil, compost addition caused an important increase in total nitrogen, organic carbon and organic matter, depending on the type and the level of applied amendment.

Regarding carbon mineralization, CO_2 quantities emitted by microorganisms in the amended parcels by compost of household wastes were higher than that amended with manure, letting us conclude that organic matter of manure is less biodegradable than that of compost, since manure organic matter is more resistant to the micro-organisms decomposition.

Addition of compost or manure acted significantly on the characteristics of the soil, especially on the soil fertility and its productive capacity. Moreover, organic level was improved, resulting in a higher organic carbon content which contributes to diminish climatic heating. However, there is a risk of soil and plants contamination by heavy metals when using household wastes compost, but it is possible to minimize this impact by acting on the applied doses.

References

1. Hudson BD. Soil organic matter and available water capacity. J Soil Water Conserv. (49) (1994) 189–94.
2. Guckert, A., Chone, T. & Jacquin, F. Microflore et stabilité structurale des sols. *Revue d'écologie et de biologie du sol*, 12 (1975) 211-223.
3. Díaz, E., Roldán, A., Lax, A. & Albaladejo, J. Formation of stable aggregates in degraded soil by amendment with urban refuse and peat. Geoderma, 63 (1994) 277-288.
4. Guerrero, C., Gõmez, I., Mataix-Solera, J., Moral, R., Mataix-Beneyto, J. & Hernandez, M.T. Effect of solid waste compost on microbiological and physical properties of a burnt forest soil in field experiment. *Biology and Fertility of Soils*, 32 (2000) 410-414.

5. Abiven, S. Relations entre caractéristiques des matières organiques apportées, dynamique de leur décomposition et évolution de la stabilité structurale du sol. *Thèse de doctorat.* Rennes, Agrocampus. (2004).
6. Annabi, M. Stabilisation de la structure d'un sol limoneux par des apports de composts d'origine urbaine: relation avec les caractéristiques de leur matière organique. *Thèse de doctorat de l'INA-PG*. (2005).
7. Analytical Software, Statistix 7.0 for Windows. Analytical Software. Tallahassee, FL, USA. (2000).
8. Meeuwissen, P. C. Champost can good concurrent met mestsoorten. *De champignon cultur*, 36(2) (1992) 95-101.
9. Kaschl, A., Romheld, V. and Chen, Y. The influence of soluble organic matter from municipal solid waste compost on trace metal leaching in calcareous soils. *The Science of Total Environnement*. 291 (2002) 45-57.
10. Glending, M.J., and Powlson, D.S. Soil management experimental basis for sustainability and environnemental quality. Workshop on long term soil management experiments, Ohio state university, USA. (1993).
11. Jedidi, N., Hassen, A., Ayari, F., Benzarti, S., Cherif, H., Bouzaiane, O., Mokni, S. et Gharbi, A. Rapport d'avancement des travaux de recherche : Etude du compostage des déchets urbains dans la station de Béja/Tunisie. Valorisation agronomique du compost. (2004) 114.
12. Brochard, D. *Magazine Mr. Bricolage* 63 (2005).
13. Diehl, R. Agriculture générale. 2ème édition. Edition J-B Baillière. (1975) 391.
14. Gros, A. in Engrais, guide pratique de la fertilisation. 6ème édition. Maison rustique. Paris. (1967) 325.