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RESEARCH ARTICLE

Effect of different organic amendment on some properties of oasis soil (Saharan region of Touggourt - Algeria)

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ABSTRACT

Local farmers combine several methods to manage soil organic matter: improve the quality and integrate other processes of managing the fertility of cultivated soils. The purpose of this work is to evaluate the effects of different organic amendments (OA) on any physico-chemical properties of the soil such as: pH, electrical conductivity (EC) and organic matter (OM). The amendments are: palm compost and manure (CPM); palm compost and reed (CPR); palm compost and reed + manure (CPRM); ovine manure (Om) and unamended soil (Ctl). The choice of materials is based on the idea of valorizing palm groves waste (palms and reeds) with ovine manure. The trial is conducted on randomized complete block design where two levels of soil samples are taken two months apart: S_0 (day zero), Sin (initial sampling before application of amendment) then, S_1, S_2 and S_3 until the end of cropping cycle. Obtained results show that all different OA increase the pH and decrease the EC of the soil after two months of application (S_1) compared to the value of the initial sampling (Sin), which demonstrates the very highly significant effect of time on both parameters in the surface horizon. For the OM an incessant increase during the assay period was noticed where Om and CPR have marked the highest values during the third sampling (S_3). This proved that the prepared composts from oasian wastes have an effect in improving soil properties over time. From an economic point of view, CPR showed results of OM that are similar of Om, which is considered as the most used and expensive manure in the region.

Keywords: Compost; Oasis; Organic amendment; Valorization; Wastes

INTRODUCTION

Evolution of soils and their properties is closely linked to their organic profile in terms of quantity and quality **(**Lashermes et al., 2007**)**. In the northern Algerian Sahara, soils have poor physical and chemical characteristics and formed mainly by erosive inputs. Enhancement of soil fertility and crop productivity needs more contributions with organic amendments.

In fact, this has also positive effects on physicochemical properties as: pH, cationic exchange capacity (CEC), electrical conductivity (EC). Manga et al. (2017) concluded that it could reduce salinity of soils characteristic of arid regions through enhancement of soil microbial profile. Therefore, organic amendments are a sustainable tool for increasing soil fertility and organic status.

Generally, compost inputs reflect consequently an enrichment of carbon, nitrogen with organic and mineral phosphorus reserve of soils. According to Laouar et al. (2020), this contribution supplements the soil mainly with humus, which is the basis of soil fertility and conservation, as well as makes certain properties of soil that are exhausted by intensive cultures. Thus, enrichments of soil and its duration of stand after application are linked to the quality of compost brought (Guenon et al., 2016). Likewise, ovine manure is properly balanced with fertilizing elements, therefore 99% of the whole organic manure are bought and used by regional farmers (Merrouchi, 2009).

Within the oasis, there are significant amounts of date palm waste that are commonly burned (Tirichine et al., 2017). This situation requires more thinking about an alternative technique for recycling waste in order to be used back as

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organic amendment by providing comparable or higher incomes to farmers.

In fact, incorporation of date palm waste as amendment is very encouraging. Oustani (2016) and Benabderrahim et al. (2017) reported that local organic matter such as date palm residues are beneficial because they mask the negative effect of soil salinity and enhance the organic matter content. As for Tirichine et al. (2020), they demonstrated that oasis waste compost gives the best result on maize crop therefore it is considered the most suitable to increase the soil skills in similar regions. Abid et al. (2020) they reported that in addition that the use of date palm waste provides OM for a sustainable agriculture it can also be an efficient environmentally-friendly and economically viable solution. Hence, results must be confirmed then generalized on the whole date palm trees areas.

This study aims to valorize the residues of date palm together with ovine manure in order to prepare different types of compost and subsequently compare their effects on certain oasis soil properties.

In addition, defining the duration of the effect of modification by intervals sampling. Achieve environmental and economic objectives by incorporating recycling of oasis wastes in fertilization of the soil.

MATERIALS AND METHODS

Experimental site

The study was conducted at the National Institute of Agronomic Research of Algeria (INRAA), experimental station of Sidi Mehdi - Touggourt (33^0 04' 26"N; 06^0 05' 45"E; 85 m a.s.l) (Fig.1). The climate is Saharan to mild winter. Generally, soils of this area are salty to very salty, loose and aerated. Organic matter content, as a nitrogen source, is generally very low with an alkaline to rather alkaline pH (Tirichine et al., 2020). Irrigation water used in the mentioned station, it comes from a forage characterized by a EC of 5.3 mS/cm and a pH of 7.48.

Physico-chemical characterization of soil site

Before any treatment, some analyses were carried out on the soil of the entire site for a general physico-chemical characterization. The granulometry was conducted by the sedimentation method. The bulk density was measured by the cylinder method. It represents the ratio of dry mass to apparent volume. Calcium carbonate content was determined using a volumetric calcimeter. Finally, electrical conductivity (EC) and pH were also defined on the basis of a soil solution (1/5).

Fig 1. Experimental site

Preparation of the various organic amendments

The amendments to be studied are ovine manure and three types of composts of different compositions of vegetable origin traditionally produced at INRAA. Reed (*Phragmite communis* Trin.) in a green state and manure are used as a source of nitrogen with dry leaves of palm date (carbon matter). Ovine manure comes from local dealers, whereas the green reed and dry palms oasian wastes are brought from INRAA farm then crushed in large tonnage.

Composting technic involves recycling all the materials, according to the study of Tirichine et al. (2017), by mixing 3/4 of the crushed and hydrated palms with 1/4 of the nitrogen source. Compost was arranged as a windrow (2 x 1.5 x 0.8 m). This was returned upside down for aeration when the indoor temperature rises. It was watered to maintain a humidity of about 50%.

The study is about four different modalities (Fig. 2):

- Ovine manure (Om);
- Compost of palms and manure (CPM);
- Compost of palms and reed (CPR);
- Compost of palms and (reed + manure) (CPRM).

Physico-chemical analyses of organic amendments

Some parameters were studied such as:

- pH and EC were analyzed on an amendment/water of (1/5) ratio;
- Assimilable phosphorus (P_2O_5) was analyzed by Olsen's method;
- Assimilable potassium (K_2O) was analyzed by photoelectric flame photometer;
- Total nitrogen was analyzed by Kjeldahl's method;
- Organic matter (OM) was analyzed by calcination method (loss in fire);
- Organic carbon (OC) was deducted according to the formula:

$$OC(\%) = OM/1.72$$

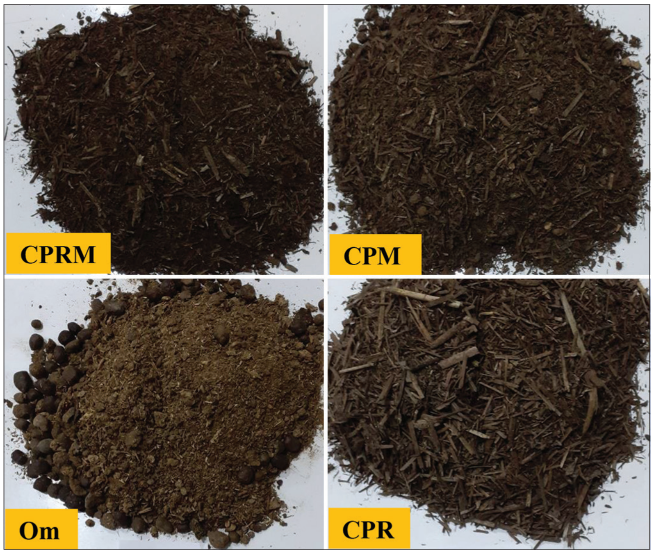

Fig 2. The various organic amendments

Experimental setup

Experimental assay was implemented as complete random blocks of three replicates. It includes four organic amendments (Fig. 3) with one control (no input). Each treatment was applicated at three plots of 2 m² on which barley (of local variety Chetrt) was manually seeded in November, with 16 g/m² of rate on six lines that are spaced with 20 cm apart. The inter-block distance is about 1 m. After seedling, plants are regularly watered twice a week by submersion system.

Soil sampling and analysis

From each plot, two samples of soil were taken from two different depths (0-20 and 20-40 cm) with 4 replicates taken during six months. An initial levy (S_0) was before introducing of amendments. Then, three samples of amended soil (S_1, S_2 and S_3) were taken every two months until the end of the crop cycle. Sampling was taken at the center of each plot using an auger, brought to INRAA laboratory, dried then sieved to 2 mm.

The physico-chemical analyses (pH, EC and OM) of these samples reflect the effect of different organic amendments on soil properties. Regarding organic matter, it was studied according to the Walkley-Black's method. It consists of the determination of organic carbon oxidized by potassium bichromate ($K_2Cr_2O_2$) on sulphuric acid medium(Mathieu and Pieltan, 2003). The obtained reduced amount is proportional to organic carbon content. Finally, OM was deduced by formula mentioned above.

Statistical analysis

In this study, the assumption of statistical analysis of all data was verified using Leven's homogeneity of variance and Shapiro-Wilk's normality tests applied on the dependent

Fig 3. Adding the organic amendments to the soil

variables (pH, EC and OM) related to the groups of the factorial variable (treatments and sampling). On the basis, if the last assumption is fulfilled, the parametric tests (One and Two Ways of analysis of variance (ANOVA)) were applied. If ANOVA results are significant ($P < 0.05$), Tukey's Honestly Significant Difference (HSD) test was taken as a post hoc analysis for means comparison. Otherwise, K-Independent Sample Kruskal-Wallis test is useful (Mayers, 2013). All statistical analyses were performed using SPSS statistical software version 20.0.

RESULTS AND DISCUSSION

Granulometry appears a loamy sand texture with higher sand contents of 77.43% on the surface layer and 77.59% on the second below. Bulk density is relatively high. While pH is close to neutral and the EC is about 2.98 mS/cm at the surface layer. The soil is considered poor in organic matter with low total limestone (Table 1).

Organic amendments presented a pH around slightly basic values with very high EC. On the other hand, the results mentioned in Table 2 show that different levels of total nitrogen (N), assimilable potassium (K_2O) and assimilable phosphorus (P_2O_5). Organic matter has considerable values extended between (43.30 – 61.71%).

Effect of organic amendments and sampling on the pH of soil

pH of horizon 1

After two months (S_1), pH values of all organic amendments at horizon level (Hz1) are higher than their initial pH sampling (Sin) (6.82). Amended soils floated around slightly basic values while the unamended one (control) presented a minor augmentation (Fig. 4). The rise is justified by used amendments carrying a pH significantly higher than the initial soil, which makes it high in the cultivated soil.

Table 1: Physico-chemical characteristics of the experimental site

Depth (cm)	pH	EC (mS/cm)	OM (%)	Bd (g/cm^3)	T $CaCO_3$ (%)	Granulometry (%)				
						C.Sd	F.Sd	C.St	F.St	C
0-20	6.82	2.98	0.78	1.57	1.60	17.03	60.40	11.94	6.13	4.51
20-40	6.79	2.33	0.71	1.75	1.60	17.35	60.24	12.39	4.36	5.66

EC: electrical conductivity, OM: Organic matter, Bd: Bulk density, T. $CaCO_3$: Total calcium carbonate, C.Sd: Coarse sand, F.Sd: Fine sand, C.St: Coarse silt, F.St: Fine silt, C: Clay.

Table 2: Physico-chemical characteristics of organic amendments

Amendments	Parameters							
	pH	EC (mS/cm)	O.M. (%)	O.C. (%)	C/N	N (%)	P_2O_5 (ppm)	K_2O (ppm)
CPM	7.15	9.87	61.71	35.87	24.07	1.49	537.35	440
CPR	7.45	16.35	43.30	25.17	16.45	1.53	364,94	394.03
CPRM	7.52	14.89	59.70	34.71	35.41	0.98	278.73	740.19
Om	7.66	7.47	52.87	30.73	24.98	1.23	968.39	878

EC: Electrical conductivity; O.M. Organic matter; O.C. Organic carbon; C/N: Carbon/Nitrogen ratio; P_2O_5: Assimilable phosphorus; K_2O: Assimilable Potassium.

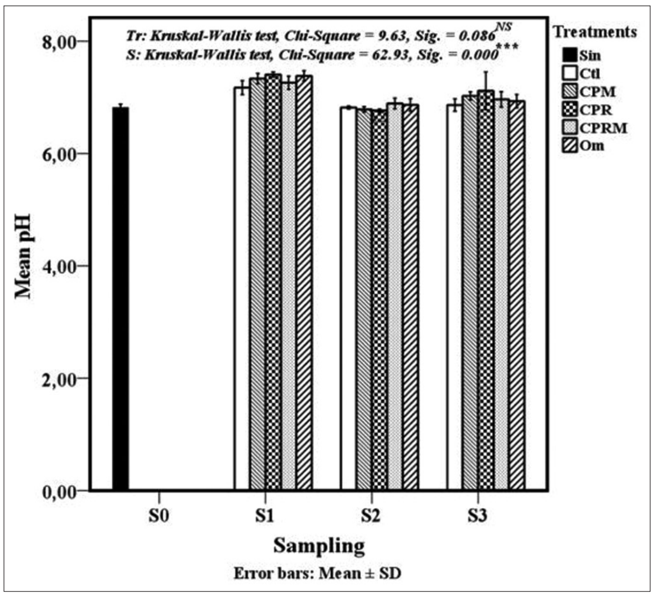

Fig 4. Variation of soil pH depending on treatments and sampling (Horizon1)

Similar results were reported by N'dayegamiye (1990), Toundou et al. (2014) and Ferdinand et al. (2018). On the other hand, Chalhoub (2013) demonstrated that several types of urban composts increase the pH of cultivated soil compared with initial value.

During the last samplings and under irrigation effect, decomposition of organic amendments could further acidify the soil and decrease the pH compared to S_1 sampling. Identical results were obtained by Koul (2007), and Diatta et al. (2019).

Statistical analysis of Kruskal-Wallis test (χ^2 (3) = 62.93, Sig.= 0.000 < 0.05) shows a very highly significant effect of sampling factor (time of sampling) on the pH of soil (Fig. 4), which increased immediately after the adding of the amendment, then decreased for the rest of the experimental period.

The multiple pairwise comparisons test (Table 3) proves a very high significance that came from differences between (S_1-S_0), (S_2-S_1), (S_3-S_1) and the last pair (S_3-S_2).

The pH of soil during the experiment reveals no significant difference between the types of organic amendments (treatments).

pH of horizon 2

After the contribution of organic amendments, a slight increase of pH is noticed of treatments (CPM, CPR and Om), followed by a decrease in S_2 for all treatments. Moreover, the pH of S_3 relatively remains unchanged around the initial value (Fig. 5).

ANOVA test (F (1, 2) = 33.996, Sig.= 0.000 < 0.05) confirms that the effect of sampling time on the pH of soil at Hz2 is very highly significant (Fig. 5).

Correspondingly, Tukey HSD test determines the source of differences between means of pairs (Table 4). Meanwhile, the types of treatments have no significant effect on this variable.

The interaction between both parameters (Tr * S) decreases the average values of pH which are significant at S2 (four months of the experiment) for all treatments (Fig. 5).

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Table 3: Independent samples Kruskal-Wallis test with pairwise comparisons of sampling and homogeneous subsets summary

Sampling (S) effect on soil pH S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean rank difference (I - J)	Sig.	Decision
$S_1 - S_0$	a – bc	54.05	0.000	***
$S_2 - S_0$	b – bc	1.78	1.000	N S
$S_3 - S_0$	c – bc	24.16	0.097	N S
$S_2 - S_1$	b – a	52.28	0.000	***
$S_3 - S_1$	c – a	29.89	0.000	***
$S_3 - S_2$	c – b	22.39	0.010	*

*Significant, ***Very Highly significant, NS: no significant. Values followed by different letters are significantly different at P < 0.05.

Table 4:. Two-Way ANOVA, Tukey's (HSD) Post hoc multiple comparison of sampling with homogeneous subsets summary

Sampling (S) effect on soil pH S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean difference (I-J)	Sig.	Decision
$S_0 - S_2$	b – a	0.1678	0.000	***
$S_1 - S_0$	b – b	0.0637	0.359	N S
$S_1 - S_2$	b – a	0.2315	0.000	***
$S_1 - S_3$	b – b	0.0611	0.123	N S
$S_3 - S_0$	b – b	0.0026	1.000	N S
$S_3 - S_2$	b – a	0.1704	0.000	***

***Very Highly significant, NS: no significant. Values followed by different letters are significantly different according to the Tukey's test (P < 0.05).

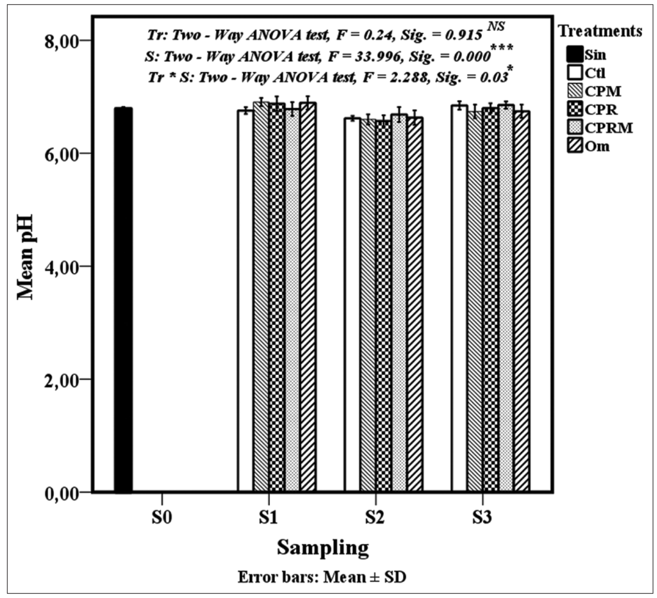

Fig 5. Variation of soil pH depending on treatments and sampling (Horizon 2)

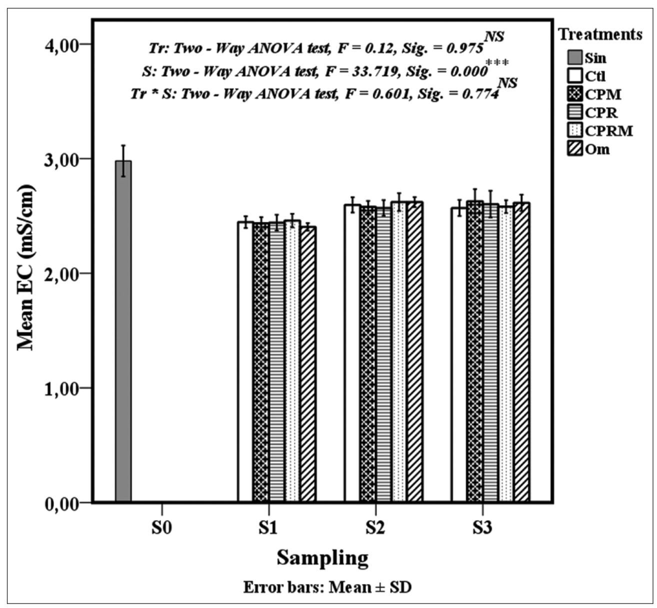

Fig 6. Variation of soil EC depending on treatments and sampling (Horizon1)

Effect of organic amendments and sampling on electrical conductivity (EC)

EC of horizon 1

The obtained results show that EC is decreasing for all treatments almost equally after two months of the amendments setting (sampling 1). This is due to the leaching of salts into the soil solution by irrigation in H1. Likewise, Oustani (2016) and Benabderrahim et al. (2017) reported that the involvement of organic matter reduces EC in salty soils. On the other hand, EC is slightly increasing at S_2 of which values are persisting until the end of the test (S_3). According to Chang et al. (1991), the application of amendments with high salt concentrations can lead to the accumulation of soluble salts in the soil over time, the case of our study. Furthermore, Koul et al. (2016) indicated that the increase of EC during the experiment is due to the mineralization of the organic matters brought in. Our study confirmed these explications, and then the EC of control registered important values. This exceptional case is probably happened because of the salts brought during irrigation (Fig. 6).

The analysis of variance (F (1, 4) = 0.12, Sig.= 0.975 > 5%) shows a non-significant effect of organic amendment on EC of soil (Fig. 6).

During the period of experimentation (Fig. 6), a very highly significant effect (F (1, 2) = 33.719, Sig.= 0.000 < 5%) of the factor (sampling time) on EC can be determined. Tukey test (HSD) reveals the sources of the differences between the sampling pairs namely: (S_0-S_1), (S_0-S_2) and (S_0-S_3), where the differences in means are respectively: 0.54, 0.38 and 0.37. These are highly significant for the benefit of S0 (Table 5). Differences between pairs, (S_3-S_1) and (S_2-S_1) have the same significance with respectively different means: 0.17 and 0.16.

The mean difference of (S_3-S_2) registered the lowest value (0.005), which is statistically non-significant (P > 0.05). Generally, EC remains stable in this period for all treatments.

Table 5: Two-Way ANOVA, Tukey's (HSD) Post hoc multiple comparison of sampling with homogeneous subsets summary

Sampling (S) effect on soil EC S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean difference (I-J)	Sig.	Decision
$S_0 - S_1$	c – a	0.543	0.000	***
$S_0 - S_2$	c – b	0.382	0.000	***
$S_0 - S_3$	c – b	0.377	0.000	***
$S_3 - S_1$	b – a	0.166	0.000	***
$S_2 - S_1$	b – a	0.161	0.000	***
$S_3 - S_2$	b – b	0.005	0.996	N S

***Very Highly significant, NS: no significant. EC: electrical conductivity. Values followed by different letters are significantly different according to the Tukey's test (P < 0.05).

The effect of the interaction between both factors (Tr * S) on EC of soil appears non-significant (Fig. 6).

EC of horizon 2

All treatment means are slightly increased from 2.33 to 2.68 mS/cm as a maximum value in CPM at S_2. Further at S_3, EC of control soil makes the lowest value, close to S_0. This is explained by the mineralization of the organic amendments contributions that lead to ions release where the increase of electrical conductivity is indicated. Numerous studies presented identical results (Van De Kerkhove, 1990; Jendoubi et al., 2014; Laouar et al., 2020).

The minor increase of EC at Hz2 is probably due to the slightly anaerobic environment of this layer, which will slow down the mineralization process of the organic matter. Based on this, a very highly significant effect of the sampling factor (time) on EC can be defined (Fig. 7). Kruskal-Wallis test (χ^2 (3) = 44.93, Sig.= 0.000 < 0.05) reveals that the sources of the differences of medians between pairs of samples are: (S_2-S_0) and (S_2-S_1) in favor of S_2, as well as (S_3-S_2) to the benefit of S_3. Therefore, the mentioned pairs indicate a very highly significant effect of soil sampling on the EC at Hz2 (Table 6). Moreover, different organic amendments have no significant effect on EC.

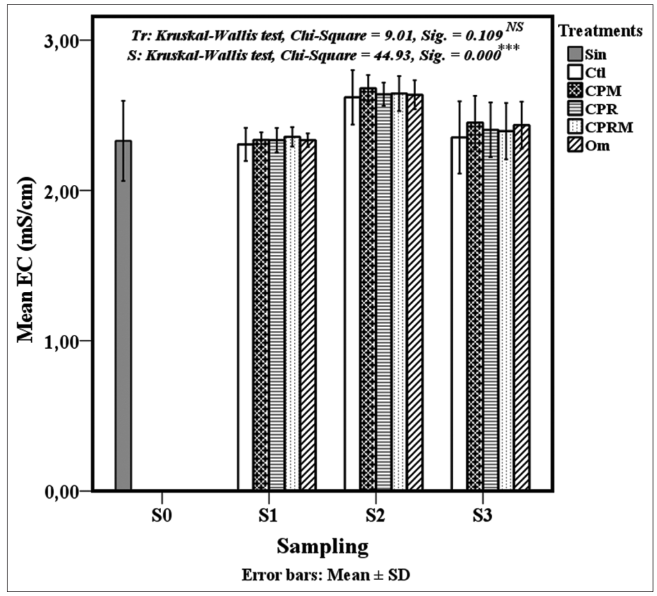

Fig 7. Variation of soil EC depending on treatments and sampling (Horizon 2)

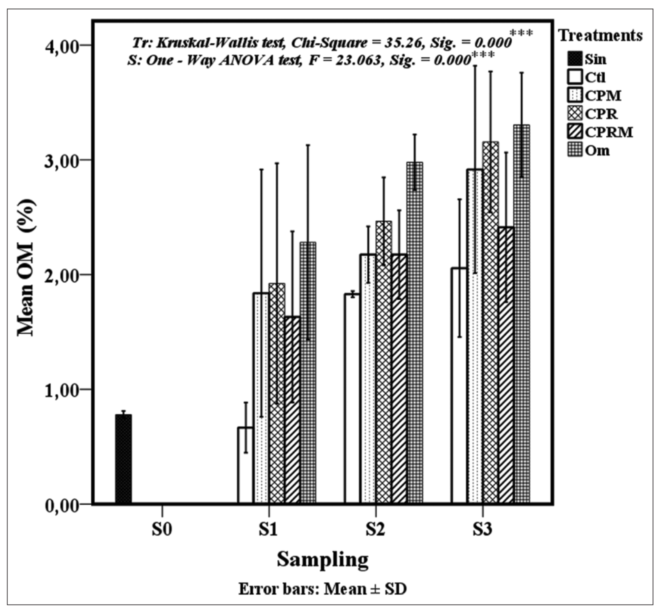

Fig 8. Variation of soil OM depending on treatments and sampling (Horizon1)

Effect of organic amendments and sampling on organic matter of soil

OM of horizon 1

The obtained results (Fig. 8) show that all organic amendments increase the organic matter content of the soil during the different samplings (S_1, S_2 and S_3). At S_3, plots that received Om and CPR presented the highest levels of organic matter, about 1% more than S_1. Both amendments CPM and CPRM led to a smaller increase than the last two mentioned above. Generally, the increase in organic matter is also significantly greater in the amended plots than the control.

The variation in the evolution of organic matter between the different organic amendments is explained by its composition and degree of mineralization (Brust, 2019; Abid et al., 2020). As for Om, it has the highest value of organic matter due to the fast action of manure in poor soil (N'dayegamiye, 1990).

Statistical analysis (χ^2 (5) = 35.26, Sig.= 0.000 < 0.05) confirms that there is a very highly significant difference between the amounts of organic matter of soil (Fig. 8). This is a result of the different types of organic amendments brought out. Obtained results Table 7 demonstrate that

Table 6: Independent samples Kruskal-Wallis test with pairwise comparisons of sampling and homogeneous subsets summary

Sampling (S) effect on soil EC S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean rank difference (I - J)	Sig.	Decision
$S_1 – S_0$	b – b	10.926	1.000	N S
$S_2 – S_0$	a – b	50.87	0.000	***
$S_3 – S_0$	b – b	16.907	0.555	N S
$S_2 – S_1$	a – b	39.944	0.000	***
$S_3 – S_1$	b – b	5.981	1.000	N S
$S_3 – S_2$	b – a	33.963	0.000	***

***Very Highly significant, NS: no significant. EC: electrical conductivity. Values followed by different letters are significantly different at P < 0.05.

Table 7: Independent samples Kruskal-Wallis test with pairwise comparisons of treatments and homogeneous subsets summary

Treatment (Tr) effect on soil Organic Mater Tr (I) - Tr (J)	Homogeneous subsets Tr (I) - Tr (J)	Mean rank difference (I - J)	Sig.	Decision
Ctl – Sin	ab – a	17.111	1.000	N S
CPRM – Sin	abc – a	31.194	0.052	N S
CPM – Sin	bc – a	36.778	0.008	**
CPR – Sin	bc – a	44.667	0.000	***
Om – Sin	c – a	56.306	0.000	***
CPRM – Ctl	abc – ab	14.083	1.000	N S
CPM – Ctl	bc – ab	19.667	0.977	N S
CPR – Ctl	bc – ab	27.556	0.146	N S
Om – Ctl	c – ab	39.194	0.004	**
CPRM – CPM	abc – bc	5.583	1.000	N S
CPRM – CPR	abc – bc	13.472	1.000	N S
Om – CPRM	c – abc	25.111	0.059	N S
CPR – CPM	bc – bc	7.889	1.000	N S
Om – CPM	c – bc	19.528	0.373	N S
Om – CPR	c – bc	11.639	1.000	N S

***Very Highly significant, **Highly significant, NS: no significant. Values followed by different letters are significantly different at P < 0.05.

Table 8: One -Way ANOVA, Tukey's (HSD) Post hoc multiple comparison of sampling with homogeneous subsets summary

Sampling (S) effect on soil Organic Mater S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean difference (I-J)	Sig.	Decision
$S_1 – S_0$	b – a	0.9996	0.003	**
$S_2 – S_0$	bc – a	1.6000	0.000	***
$S_2 – S_1$	bc – b	0.6004	0.014	*
$S_3 – S_0$	c – a	2.0689	0.000	***
$S_3 – S_1$	c – b	1.0693	0.000	***
$S_3 – S_2$	c – bc	0.4689	0.081	N S

***Very Highly significant, **Highly significant, *Significant, NS: no significant. Values followed by different letters are significantly different according to the Tukey's test (P < 0.05).

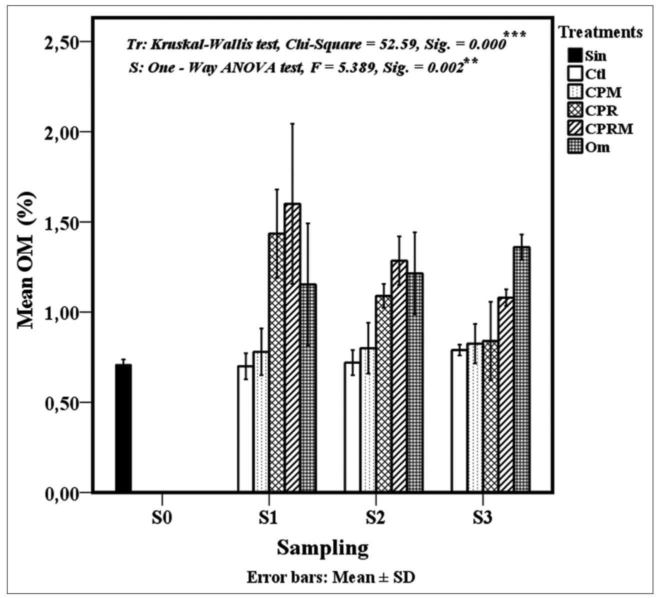

Fig 9. Variation of soil OM depending on treatments and sampling (Horizon 2)

the source of the differences between all treatments takes place between the following pairs: (Om-Sin) (CPR-Sin), (Om-Ctl) and (CPM-Sin), in which the pairs (Om-Sin) and (CPR-Sin) are very highly significant, with the highest mean rank difference namely: 56.30 and 44.66 respectively.

One-Way ANOVA results (F (1,3) = 23.063, Sig.= 0.000 < 5%) show a very highly significant difference between the means of organic matter of soil (Fig. 8) due to the difference in sampling time. Tukey test (HSD) itemizes this difference between the following pairs of samples: (S_3-S_0), (S_2-S_0), (S_3-S_1), (S_1-S_0) and (S_2-S_1) (Table 8) according to their means values. It is clear that S_3 and S_2 have the highest OM means compared to S_0.

OM of horizon 2

The effect of OM of soil amended by different treatments at Hz2 (Fig. 9) revealed that the highest mean values is recorded by the Om and CPRF while the lowest is noted on CPM. These differences are produced because of the starting composition (the raw material) of each treatment (Laouar et al., 2020). On the other hand, the OM is closely related to lignin content and degree of maturation of composts (Larbi, 2006).

Analysis of Kruskal-Wallis test (χ^2 (5) = 52.59, Sig.= 0.000 < 0.05) indicates that the type of organic amendment has a very highly significant effect on soil OM (Fig. 9). The results of multiple pairwise comparisons (post hoc) reveal differences between the treatment pairs that are presented in descending order according to the degree of significance (Table 9): (CPRM-Sin), (Om-Sin), (CPRM-Ctl), (CPRM-CPM), (Om-CPM), (Om-Ctl), (CPR-Sin), (CPR-CPM) and (CPR-Ctl).

ANOVA test (F (1, 3) = 5.389, Sig.= 0.002 < 5%) creates a highly significant difference between organic matter

Table 9: Independent samples Kruskal-Wallis test with pairwise comparisons of treatments and homogeneous subsets summary

Treatment (Tr) effect on soil Organic Mater Tr (I) - Tr (J)	Homogeneous subsets Tr (I) - Tr (J)	Mean rank difference (I - J)	Sig.	Decision
Ctl – Sin	a – a	5.667	1.000	N S
CPM – Sin	a – a	11.250	1.000	N S
CPR – Sin	b – a	38.417	0.005	**
Om – Sin	b – a	48.806	0.000	***
CPRM – Sin	b – a	51.750	0.000	***
CPM – Ctl	a – a	5.583	1.000	N S
CPR – Ctl	b – a	32.750	0.032	*
Om – Ctl	b – a	43.139	0.001	**
CPRM – Ctl	b – a	46.083	0.000	***
CPR – CPM	b – a	27.167	0.027	*
Om – CPM	b – a	37.556	0.000	***
CPRM – CPM	b – a	40.500	0.000	***
Om – CPR	b – b	10.389	1.000	N S
CPRM – CPR	b – b	13.333	1.000	N S
Om – CPRM	b – b	2.944	1.000	N S

***Very Highly significant, **Highly significant, *Significant, N.S: no significant. Values followed by different letters are significantly different at P < 0.05.

Table 10: One -Way ANOVA, Tukey's (HSD) Post hoc multiple comparison of sampling with homogeneous subsets summary

Sampling (S) effect on soil Organic Mater S (I) – S (J)	Homogeneous subsets S (I) – S (J)	Mean difference (I-J)	Sig.	Decision
$S_1 – S_0$	b – a	0.472	0.001	**
$S_1 – S_2$	b – b	0.1263	0.449	N S
$S_1 – S_3$	b – ab	0.182	0.148	N S
$S_2 – S_0$	b – a	0.3456	0.025	*
$S_2 – S_3$	b – ab	0.0556	0.914	N S
$S_3 – S_0$	ab – a	0.2900	0.082	N S

**Highly significant, * Significant, N.S: no significant. Values followed by different letters are significantly different according to the Tukey's test (P < 0.05).

amounts at Hz2 depending on the sampling time (Fig. 9). Those mentioned in Table 10 present a significant difference between means of pairs namely: (S_1-S_0) in favor of S1 besides (S_2-S_0) in favor of S_2, while the other differences between pairs remain non-significant.

GENERAL CONCLUSION

In oasian environments where organic amendments are based on manure contributions, often purchased, in order to fertilize soils that are relatively poor in organic matter amounts.

The study was carried out at INRAA Touggourt, with the aim of studying the effect of different organic amendments (three kinds of compost made from the recycling of available waste in palm groves + ovine manure) on some physico-chemical properties of soil.

In the light of the obtained results, it can be concluded that various organic amendments show a tendency of pH to alkalinity just after two months (S_1) with the decreasing of the EC. On the other hand, the types of amendments do not differ statistically from each other on the two layers.

The contribution of the different organic amendments leaded to a very highly significant increase in the OM rates between the initial sampling (Sin) and the end of the experiment (S_3). The highest values are obtained by Om and CPR on the superior layer.

It is concluded that compost of oases wastes that are balanced on carbon and nitrogen materials can be considered as an effective organic amendment in improving the physico-chemical properties of soils over time. Therefore, it is an economical and environmental solution that can substitute ovine manure.

Author contributions

- AF. A. performed the field experiments, the lab work and wrote the manuscript.
- M. B., AF. A. and I. S. conducted the statistical analysis and prepared the figures & tables.
- B. B. supervised the research project. All of the authors agreed on the manuscript.

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