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# EFFECT OF BIODEGRADATION OF SOME SOIL CONDITIONERS ON SOIL PROPERTIES UNDER SALINE WATER CONDITIONS

**BY**

**Ashour, I.A., M.H.Ali, Farh. A. Hashem and Asmaa Sayed**
Desert Research Center, Mataria, Cairo, Egypt.

## ABSTRACT

A factorial pot experiment was conducted under laboratory conditions to study the effect of biodegradation of three soil conditioners (bitumen "Bit", polyacrylamide "PAM" and town refuse "TR") on soil properties at temperature degrees (20 – 30°C) and incubation periods (3, 30, 60 and 90 days) using saline water. The changes in physical, chemical and microbiological properties of a calcareous soil due to the application and biodegradation of soil conditioners were taken into consideration. The results showed that total bacterial counts and $CO_2$ evolution increased with adding soil conditioners and the best treatment was for town refuse (TR). Increasing the incubation period or temperature resulted in increasing total bacterial counts regardless of all the experimental treatments. The organic carbon content of the investigated calcareous soil was increased with applying soil conditioners. The highest value of organic carbon was obtained with bituminous emulsion application. The temperature at 30°C or increasing the incubation periods increased the microbial activity which led to a decrease in organic carbon content of the soil. The application of all soil conditioners with temperature at 30°C and increasing incubation period led to increase total nitrogen content as well as, $NH_4$–N and $NO_3$-N. In this respect the best treatment was TR under a temperature of 30°C after 60 days of incubation. Also, application of soil conditioners under saline water enhanced the formation of soil aggregates > 0.5 mm as compared with the control treatment. The decomposition rate of the soil conditioners varied according to the type of soil conditioners, which could be arranged as follows: TR > PAM > Bit.

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**Keywords**: Total bacterial counts, $CO_2$ evolution, organic carbon, total nitrogen, $NH_4$–N, $NO_3$-N, saline water, soil conditioners.

## INTRODUCTION

Natural and synthetic soil conditioners have been used for long time ago in the reclamation of desert soils for sustaining its productivity. The suitability of one conditioner or another depends mainly upon its ability to improve the hydro - physical, chemical and biological properties of the soil The addition of organic conditioners may; reduce the toxicity of contaminants by sorption or dilution, provide the primary carbon and energy sources for the microbial population and increase population of various microbial species including those involved in degradation and detoxification of contaminants (Terry, 1998). However, such materials when added to the soil, will be attacked by soil microflora resulting in the breakdown or biodegradation of soil conditioners. Bituminous emulsion is environmentally safe as it results in no leaching of hazardous substances into groundwater (Walker, 1995). The extent of biodegradation of the applied soil conditioners depends upon their chemical structure as well as the prevailing environmental conditions affecting the microbial activity, such as soil moisture, soil temperature, salinity levels of the soil and/or saline irrigation water (Senior *et al.*, 1972, El-Hadidy *et al.*, 1976; El-Khawas 1981; Jena *et al.*, 1988; and El-Tayeb, 2000). Egypt is arid in the north and hyper arid in the south. The calcareous soils of these regions are mostly characterized by their low CEC, negligible organic matter, alkaline pH and high $CaCO_3$. Therefore, the aim of this work is to study the effect of adding some soil conditioners on biological, chemical and physical properties of calcareous soil under different environmental conditions such as soil temperature, water salinity and incubation period. Also, to study to what extent the microbial activity due to the application of soil conditioners, contribute to the breakdown or biodegradation of such materials. The ability of these materials to be decomposed by soil microorganisms was also studied.

## MATERIALS AND METHODS

A factorial pot experiment was conducted under laboratory conditions to study the role of soil microorganisms on the biodegradation process of some soil conditioners. Also, the effect of the used conditioners on soil properties was taken into consideration. A surface calcareous soil sample, (0-25 cm), was collected from Maryout experimental station, Alexandria Governorate, Egypt.

The soil was air dried, ground, thoroughly mixed to pass through a 2 mm sieve. Table (1) depicts some of the physical, chemical and microbological properties of the investigated calcareous soil. Three soil conditioners; bitumenous emulsion, polyacrylamide and town refuse were mixed with such soil. Table (2) shows some chemical analysis of such conditioners. The experiment included 56 pots, each pot was filled with 400 g of the investigated calcareous soil. The pots were divided into seven main groups (8 pots per each). Each group (8 pots) was treated with one of the following conditioners respectively:

Without adding conditioner (control), bitumenous emulsion at the rates of 0.1 and 0.2 L/m$^2$ of soil (denoted as $Bit_1$ and $Bit_2$), polyacrylamide at the rate of 0.01 and 0.02 % (denoted as $PAM_1$ and $PAM_2$) and town refuse at the rates of 10 and 20 m$^3$/fed (denoted as $TR_1$ and $TR_2$). Then each main group was divided into two sub-main groups (4 pots per each). The first section was incubated at 20°C while the other one was incubated at 30°C. Finally, the pots of each section (4 pots) were exposed to one of the following incubation periods 3, 30, 60 and 90 days respectively. The pots were irrigated with saline water, 3000 mg/l prepared from NaCl salt. At end of each incubation period samples of each pot were taken and prepared for the biological, chemical and physical analysis as follows: total counts of bacteria were estimated by plate count technique using soil extract yeast agar medium after Skinner *et al.*,1952, modified by Mahmoud *et al.*, 1964. The development of $CO_2$ in soil was measured as an indication of the metabolic activities of soil microorganisms by method of Pramer and Schmidt (1964) modified by Shehata (1972). Organic carbon was determined by rapid titration method of Walkely (1935, 1947). Ammoniacal nitrogen in soil was determined using distillation method described by Page *et al.*, 1982. However, ($NO_3$–N) was determined according to Richard (1954). The total nitrogen in soil was determined using modified Kjeldahl method as described by Cottenie *et al.*, (1982). Finally, water stable aggregates were determined according to Black (1973).

**Table (1): Some physical, chemical and microbiological properties of the calcareous soil used in the experiment.**

**a) Physical and chemical properties:**

| Particle size distribution | | | |
|---|---|---|---|
| **Sand** | **Silt** | **Clay** | **Textural class** |
| **%** | | | |
| 40.90 | 55.00 | 4.10 | Silt Loam |
| **Chemical properties** | | | |
| $CaCO_3$ (%) | | 27.50 | |
| pH | | 7.65 | |
| E.C. $dS.m^{-1}$ | | 2.20 | |
| Organic carbon (%) | | 0.25 | |
| Total N $mg.kg^{-1}$ | | 100 | |
| $NH_4$-N $mg.kg^{-1}$ | | 17 | |
| $NO_3$-N $mg.kg^{-1}$ | | 18 | |

**b) Microbiological analysis:**

| Initial counts of microorganisms | |
|---|---|
| **Total bacterial counts** | **$0.8x10^6$/g. dry soil** |
| **$CO_2$ evolution** | **5µg $CO_2$/g. dry soil/hr.** |

**Table (2): Chemical analysis of the used soil conditioners**

| Component (%) | Soil conditioners | | |
|---|---|---|---|
| | **Bitumenous emulsion (Bit)** | **Town refuse (TR)** | **Polyacrylamide (PAM)** |
| **Organic carbon** | 85.44 | 18.20 | 82.55 |
| **Total N** | 0.65 | 0.92 | 1.63 |

## RESULTS AND DISCUSSIONS

**Soil microbial activity as affected by adding soil conditioners:**

Data presented in Table (3) clearly appear that, the total bacterial counts (T.B.C.) found in the studied calcareous soil varied according to type and rate of soil conditioners, period and temperature of incubation. For example, the application of $Bit_2$ increased the T.B.C., as the rate of increment over the control reached 66.66 %.after 3 days incubation period at 20°C, while the respective increment reached 17.52% at 30°C. Also, the studied microbial counts were progressively increased with increasing time of incubation up to 90 days. The positive effect of bitumen on increasing the microbial activity may be rendered to its role in improving some physical properties of the calcareous soil under investigation such as water stable aggregates (Table, 8) and due to increasing the ability of the soil to hold water against evaporation (El-Maghraby *et al.*, 1997), beside, the higher organic carbon content found of such material (Table, 2). Consequently, the soil microorganisms would have a better environmental conditions to grow well. As a result soil microbial activity was increased. Such results are in agreement with those found by El Maghraby *et al.*, (1996). Similar trends were also obtained when the studied calcareous soil was treated either with polyacrylamide (PAM) or town refuse (TR). The rate of increment in T.B.C. over the control reached 411.63 and 330.23 % due to $PAM_2$ and $TR_2$ after 90 days incubation period at 30°C, respectively. The positive effect of PAM and TR on increasing such microbial counts could be referred to their influence on increasing soil moisture content. (El-Sersawey, *et al.*, 1992). The same trend was obtained with $CO_2$ production where all used experimental treatments enhanced $CO_2$ production. However, the magnitude of increase depended upon the type of soil conditioner, temperature and period of incubation. The application of soil conditioner increased the $CO_2$ production by 148.82, 149.85 and 136.31 % for $TR_2$, $PAM_2$ and $Bit_2$, respectively, regardless of the other experimental treatments. The positive effect of such soil conditioners on increasing $CO_2$ evolution may be attributed to the role of soil conditioners in improving soil properties during the experiment making it more suitable for microbial activity. This result is confirmed by the findings of Abd El-Ghany (1994) and Hashem (1996). Generally, the overall changes in microbial counts or $CO_2$ evolution as affected by the experimental treatments could be summarized as follows:

(1) Increasing incubation period up to 60 days was also effective in most cases in increasing the microbial counts and $CO_2$ production regardless of the rest of experimental treatments. (2) Increasing incubation temperature up to 30°C resulted in increasing microbial counts and $CO_2$ production, over their counts under 20°C regardless of the rest of experimental treatments. This means that the 30°C could be considered relatively more suitable temperature for microbial growth. (3) The T.B.C. was also affected favorably by the type of the applied soil conditioners which can be arranged in the following order: $TR_2 > PAM_2 > TR_1 > PAM_1 > Bit_2 > Bit_1 >$ control, regardless of the other experimental treatments. It is interesting to note that, the increases obtained in the microbial counts due to the used experimental treatments might contribute to the biodegradation or

Table (3) Total bacterial counts and $CO_2$ evolution as affected by experimental treatments .

| Treatments | | Soil conditioners | | | | | | | Mean of period | Mean of Temperature degree (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Period (Days) | Temperture (°C) | Control | $Bit_1$ | $Bit_2$ | $PAM_1$ | $PAM_2$ | $TR_1$ | $TR_2$ | | 20 | 30 |
| Total bacterial counts (count X $10^6$) | | | | | | | | | | | |
| 3 | 20 | 0.90 | 1.30 | 1.50 | 1.90 | 2.10 | 2.00 | 2.50 | 2.09 | 18.75 | 20.26 |
| | 30 | 1.70 | 1.80 | 2.00 | 2.50 | 3.00 | 2.70 | 3.30 | | | |
| 30 | 20 | 5.50 | 9.00 | 15.00 | 29.00 | 35.00 | 34.00 | 39.00 | 24.68 | | |
| | 30 | 5.00 | 13.00 | 18.50 | 31.00 | 36.50 | 36.00 | 41.00 | | | |
| 60 | 20 | 4.20 | 10.00 | 17.00 | 31.00 | 37.00 | 36.00 | 40.00 | 25.99 | | |
| | 30 | 5.00 | 14.50 | 17.60 | 33.00 | 38.00 | 38.50 | 42.00 | | | |
| 90 | 20 | 5.50 | 12.00 | 19.50 | 34.00 | 40.00 | 29.00 | 31.00 | 25.26 | | |
| | 30 | 8.60 | 16.00 | 9.00 | 36.00 | 44.00 | 32.00 | 37.00 | | | |
| Mean of Soil conditioners | | 4.55 | 9.70 | 12.26 | 24.80 | 29.45 | 26.28 | 29.48 | | | |
| $CO_2$ evolution (µg $CO_2$/g.dry soil/hr.) | | | | | | | | | | | |
| 3 | 20 | 5.50 | 5.60 | 5.70 | 5.80 | 5.90 | 5.60 | 5.60 | 5.96 | 19.64 | 22.59 |
| | 30 | 6.10 | 6.10 | 6.20 | 6.30 | 6.40 | 6.30 | 6.30 | | | |
| 30 | 20 | 12.60 | 21.50 | 23.60 | 23.20 | 25.30 | 25.50 | 29.00 | 24.76 | | |
| | 30 | 14.30 | 25.70 | 28.30 | 27.90 | 29.80 | 29.00 | 31.00 | | | |
| 60 | 20 | 9.70 | 24.50 | 25.70 | 26.70 | 29.00 | 27.30 | 30.70 | 26.59 | | |
| | 30 | 11.60 | 28.30 | 31.40 | 30.80 | 32.50 | 31.00 | 33.00 | | | |
| 90 | 20 | 8.00 | 26.90 | 28.00 | 29.00 | 31.00 | 25.50 | 27.50 | 27.14 | | |
| | 30 | 10.20 | 30.50 | 35.40 | 33.00 | 35.00 | 29.00 | 31.00 | | | |
| Mean of Soil conditioners | | 9.75 | 21.14 | 23.04 | 22.84 | 24.36 | 22.40 | 24.26 | | | |

breakdown of the used soil conditioners, which will be discussed later. Such results are in agreement with those found by El Maghraby *et al.* (1996) and El-Tayeb (2000).

**Changes in soil organic carbon as a result of adding soil conditioners:**

Data presented in Table (4) show that the soil organic carbon content of the investigated soil was favorably affected by soil conditioners application as the rate of increment over the control reached 123.53, 64.12 and 33.53 % for $Bit_2$, $PAM_2$ and $TR_2$ treatments, respectively. The positive effect of Bit. and PAM on increasing soil organic carbon content may be due to their chemical composition which contains large amount of hydro carbon chains. These chains would be attacked by soil microorganisms and as a result the organic carbon content of the soil increased.

**Table (4): Soil organic carbon as indication of biodegradation for soil conditioners under different experimental treatments.**

| Treatments | | Soil conditioners | | | | | | | Mean of period | Mean of temperature degree (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Period (Days) | Temp. (°C) | Control | $Bit_1$ | $Bit_2$ | $PAM_1$ | $PAM_2$ | $TR_1$ | $TR_2$ | | 20 | 30 |
| | | Organic carbon (g/kg) | | | | | | | | | |
| 3 | 20 | 1986 | 3270 | 4801 | 2860 | 3240 | 2230 | 2769 | 2744 | 2866 | 2331 |
| | 30 | 1710 | 3130 | 3270 | 2280 | 2670 | 1930 | 2265 | | | |
| 30 | 20 | 1860 | 3101 | 4612 | 2752 | 3150 | 2120 | 2638 | 2613 | | |
| | 30 | 1605 | 2975 | 3100 | 2152 | 2550 | 1850 | 2120 | | | |
| 60 | 20 | 1840 | 3062 | 4532 | 2715 | 3105 | 2080 | 2582 | 2571 | | |
| | 30 | 1571 | 2915 | 3065 | 2101 | 2510 | 1840 | 2080 | | | |
| 90 | 20 | 1745 | 2973 | 4500 | 2600 | 2974 | 1950 | 2210 | 2467 | | |
| | 30 | 1560 | 2880 | 3000 | 2066 | 2430 | 1662 | 1985 | | | |
| Mean of Soil conditioners | | 1697 | 2984 | 3802 | 2398 | 2787 | 2787 | 2269 | | | |

Generally, the efficiency of the used soil conditioners on increasing soil organic carbon content can be arranged in the following order: Bit > PAM > TR > control. Also, the soil organic carbon values associated with the incubating temperature at 30°C were lower than those associated with the 20°C one. This is because 30°C is more suitable temperature degree for microbial activity. The incubation periods were also effective in away that the soil organic carbon content, were decreased by increasing incubation period up to 90 days. This may be due to increasing the biological oxidation of organic carbon by increasing incubation period.

Data presented in Table (5) indicate that the decomposition rate of the soil conditioners varied according to type and rate of the soil conditioner regardless of incubation period. The decomposition rate of the soil conditioners could be arranged as follows $TR_2$ > $PAM_2$ > $Bit_2$ as the rates of their decomposition were 14.78, 5.69 and 4.91 % respectively. This means that bitumen emulsion was the most resistant conditioner to microbial attack and loss through decomposition, however, TR was the lowest one. Increasing the decomposition rate of the used soil conditioners may be attributed to the role of these conditioners in increasing the total microbial counts as previously mentioned. Data also indicate that the decomposition rate at 30°C incubating temperature was higher than at the 20°C as the decomposition rates were 5.46 and 18.73 % for 30°C and 20°C, respectively.

**Table (5): Decomposition rate of the used soil conditioners as affected by temperature degree at end of the incubation periods under saline water.**

| Soil conditioner treatments | Organic carbon of soil conditioners | | Carbon loss | | Carbon loss (%) | | Mean of carbon loss (%) |
|---|---|---|---|---|---|---|---|
| | 20°C | 30°C | 20°C | 30°C | 20°C | 30°C | |
| $Bit_1$ | 1284 | 1420 | 56.00 | 100.00 | 4.36 | 7.04 | 5.70 |
| $Bit_2$ | 2815 | 1560 | 60.00 | 120.00 | 2.13 | 7.69 | 4.91 |
| $PAM_1$ | 874 | 570 | 19.00 | 64.00 | 2.17 | 11.23 | 6.70 |
| $PAM_2$ | 4254 | 960 | 25.00 | 90.00 | 1.99 | 9.38 | 5.69 |
| $TR_1$ | 244 | 220 | 39.00 | 118.00 | 15.98 | 53.64 | 34.81 |
| $TR_2$ | 783 | 555 | 48.00 | 130.00 | 6.13 | 23.42 | 14.78 |
| Mean | | | | | 5.46 | 18.73 | |

**Nitrogen status of the investigated soil:**

Data presented in Table (6) show that the $NH_4$–N, $NO_3$-N and total N content of the soil greatly increased by application of any of the three soil conditioners as the percentages of increment due to $TR_2$, $PAM_2$ and $Bit_2$. over the control treatment reached (35.00, 34.30 and 13.54 %), (47.01, 42.31 and 32.54 %) and (585.83, 195.00 and 32.54 %) for $NH_4$–N, NO3-N and total N , respectively. The positive effect of the used soil conditioners on increasing $NH_4$–N content of calcareous soil may be due to original their contents of nitrogen and

Table (6) Ammoniacal nitrogen, nitrate nitrogen and total nitrogen as indication of biodegradation for some soil conditioners under different experimental treatments

| Treatments | | Soil conditioners | | | | | | | Mean of period | Mean of Temperature degree (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Period (Days) | Temperture (°C) | Control | $Bit_1$ | $Bit_2$ | $PAM_1$ | $PAM_2$ | $TR_1$ | $TR_2$ | | 20 | 30 |
| | | Ammoniacal nitrogen ($NH_4$-N mg/kg) | | | | | | | | | |
| 3 | 20 | 13.85 | 14.36 | 15.60 | 15.10 | 15.83 | 15.22 | 16.04 | 15.28 | 13.28 | 23.06 |
| | 30 | 14.50 | 14.98 | 15.65 | 15.25 | 15.95 | 15.40 | 16.17 | | | |
| 30 | 20 | 11.52 | 12.13 | 13.71 | 14.30 | 17.15 | 15.60 | 17.77 | 14.90 | | |
| | 30 | 11.39 | 12.77 | 13.88 | 14.95 | 17.55 | 17.77 | 18.10 | | | |
| 60 | 20 | 10.12 | 10.13 | 12.00 | 13.78 | 15.81 | 12.12 | 13.32 | 12.87 | | |
| | 30 | 10.00 | 10.00 | 12.33 | 14.32 | 16.00 | 14.33 | 15.89 | | | |
| 90 | 20 | 10.11 | 10.00 | 10.00 | 11.50 | 11.82 | 10.30 | 12.68 | 10.98 | | |
| | 30 | 9.50 | 9.89 | 10.12 | 11.56 | 12.07 | 11.32 | 12.86 | | | |
| Mean of Soil conditioners | | 11.37 | 11.78 | 12.91 | 13.85 | 15.27 | 14.01 | 15.35 | | | |
| | | Nitrate nitrogen ($NO_3$-N mg/kg) | | | | | | | | | |
| 3 | 20 | 13.65 | 15.00 | 19.80 | 17.12 | 20.35 | 20.65 | 24.36 | 20.77 | 29.52 | 32.14 |
| | 30 | 15.03 | 19.00 | 21.20 | 18.10 | 32.82 | 23.85 | 29.88 | | | |
| 30 | 20 | 22.09 | 27.47 | 30.91 | 28.90 | 35.61 | 30.30 | 36.20 | 31.53 | | |
| | 30 | 25.25 | 31.36 | 35.75 | 31.59 | 36.15 | 32.87 | 36.91 | | | |
| 60 | 20 | 27.91 | 34.10 | 35.00 | 32.00 | 36.50 | 35.86 | 39.34 | 35.29 | | |
| | 30 | 29.52 | 36.00 | 37.80 | 34.30 | 38.65 | 36.30 | 40.81 | | | |
| 90 | 20 | 28.87 | 35.96 | 37.30 | 32.70 | 37.30 | 33.33 | 37.88 | 35.72 | | |
| | 30 | 31.66 | 37.10 | 39.35 | 34.98 | 38.73 | 35.10 | 39.81 | | | |
| Mean of Soil conditioners | | 24.25 | 29.50 | 32.14 | 28.71 | 34.51 | 31.03 | 35.65 | | | |
| | | Total nitrogen (mg/kg) | | | | | | | | | |
| 3 | 20 | 110 | 120 | 128 | 150 | 220 | 480 | 670 | 313.14 | 292.43 | 398.68 |
| | 30 | 115 | 131 | 140 | 300 | 380 | 580 | 860 | | | |
| 30 | 20 | 120 | 127 | 139 | 162 | 259 | 520 | 720 | 343.07 | | |
| | 30 | 128 | 139 | 149 | 340 | 450 | 630 | 920 | | | |
| 60 | 20 | 122 | 129 | 140 | 169 | 265 | 580 | 740 | 363.50 | | |
| | 30 | 130 | 142 | 152 | 355 | 475 | 700 | 990 | | | |
| 90 | 20 | 115 | 130 | 143 | 175 | 275 | 550 | 730 | 362.50 | | |
| | 30 | 122 | 145 | 160 | 400 | 510 | 670 | 950 | | | |
| Mean of Soil conditioners | | 120 | 133 | 144 | 256 | 354 | 589 | 823 | | | |

breakdown through soil microbial activities. These results were in agreement with those of Zohdy *et al.*, (1983). It is interesting to note the associated effect between the $NH_4$–N content of the soil and the decomposition rate of soil conditioners, the higher the decomposition rate of soil conditioners the higher the $NH_4$–N content of the soil. The positive effect of bitumenous emulsion application on increasing $NO_3$-N content of the soil may be due to its role in improving soil aeration (El-Hady and Tayel, 1981). Consequently the soil Nitrosomonas and Nitrobacter would have a better condition for oxidizing soil $NH_4$-N into $NO_3$-N through nitrification. The positive effect of polyacrylamide application on increasing $NO_3$-N content of the soil may be due to its role in increasing nitrifying bacteria. As a result the nitrification process would be stimulated producing more nitrate. Also, the positive effect of town refuse treatment on increasing soil $NO_3$-N content may be due to its role on increasing soil organic matter content which may lead to more $NH_4$-N production which is used as an energy source for the nitrifying bacteria. As a result the nitrification process increased and more $NO_3$-N was produced. Data also indicated that the incubating temperature of 30°C was relatively better for increasing $NH_4$–N, $NO_3$-N and total N content of the calcareous soil compared to the 20°C one. This may be due to that the decomposition rate of the used soils conditioners under 30°C was higher than that under 20°C, Table (5). Data also indicated that the $NH_4$–N content of the soil gradually decrease up to the end of the experiment. This can be attributed to the nitrification process and immobilization by soil microorganisms (Zohdy *et al.*, 1983). On the other hand, $NO_3$-N and total N content of the calcareous soil were increased by increasing incubation period till end of the experiment up to 90 days. This may be due to increasing the biodegradation of the applied soil conditioners by soil microorganisms with increasing incubation time, Table (3). It is interesting to note that increasing the nitrogen content of the treated soil will reflected in increasing the nitrogen gain of the soil (is calculated from the values of total nitrogen at the beginning of the experiment – The values at the end of the experiment), Table (7). As expected, the nitrogen gain took the same trends previously mentioned for total nitrogen content of the soil since it is calculated as a percentage increase from the initial soil nitrogen. The efficiency of the used soil conditioners on increasing nitrogen gain in the soil can be arranged in the following order: PAM > TR >Bit. The values under 30°C were greater than those obtained under 20°C regardless of the soil conditioner treatments. The positive effect of the soil conditioners application under soil temperature degrees may be attributed to the factors previously discussed for total nitrogen content of soil and the best treatment was $PAM_2$ under saline water and 30°C where the percentage of $N_2$-fixation for such treatment was 34.

**Stability of soil aggregates:**

The size distribution of soil aggregates is important because it determines the dimensions of the pore space in cultivated soils, which will be reflected on aeration, and other physical properties of the soil related to microbial activity. The aggregates stability percentages are closely dependent on the types of soil conditioners. Regarding the effect of soil conditioners, data in Table (8) indicate that the application of soil conditioners increased soil aggregates > 0.5 mm as compared with the control treatment as the rate of increment over the control treatment for $Bit_2$, $PAM_2$ and $TR_2$ reached 193.3, 70.75 and 71.45%, respectively. The efficiency of the soil conditioners on increasing the percentages of soil aggregates stability is a true reflection of producing polymers such as polysaccharides and polyuronides (in case of town refuse and polyacrylamide) capable of binding soil aggregates, besides the sticky nature of bituminous emulsion. (El Maghraby, 2002) The efficiency of the used soil conditioners on increasing soil aggregates stability could be arranged in the following order: $Bit_2 > TR_2 > PAM_2$.

**Table (7): Nitrogen gain in the calcareous soil under some soil conditioners after 90 days of incubation under saline water.**

| Changes in $N_2$-Fixation | Temp. (°C) | Soil conditioners | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Control | $Bit_1$ | $Bit_2$ | $PAM_1$ | $PAM_2$ | $TR_1$ | $TR_2$ |
| Amount of nitrogen increase (mg/kg) | 20 | 5.0 | 10.0 | 15.0 | 25.0 | 55.0 | 70.0 | 60.0 |
| | 30 | 7.0 | 14.0 | 20.0 | 100.0 | 130.0 | 90.0 | 100.0 |
| Percentage of $N_2$-fixation | 20 | 4.5 | 8.3 | 11.7 | 16.6 | 25.0 | 14.5 | 8.9 |
| | 30 | 6.0 | 10.6 | 14.2 | 33.0 | 34.0 | 15.5 | 11.7 |

**Table (8): Aggregates stability percentage as indication of biodegradation for some soil conditioners under 30°C of temperature and 90 days of incubation period.**

| Soil conditioners | Aggregates percentage (%) | | | | | Mean weight diameter (µm) |
|---|---|---|---|---|---|---|
| | > 2.00 | 2.00-1.00 | 1.00-0.50 | 0.50-0.25 | < 0.25 | |
| | (mm) | | | | | |
| Control | 6.83 | 3.94 | 2.05 | 10.44 | 76.74 | 140 |
| $Bit_1$ | 14.19 | 8.65 | 13.76 | 13.16 | 50.24 | 250 |
| $Bit_2$ | 14.32 | 7.58 | 15.70 | 14.80 | 47.60 | 290 |
| $PAM_1$ | 12.23 | 1.90 | 6.03 | 17.87 | 61.97 | 230 |
| $PAM_2$ | 11.64 | 4.56 | 5.69 | 15.63 | 62.48 | 185 |
| $TR_1$ | 8.53 | 2.14 | 4.64 | 8.70 | 75.99 | 140 |
| $TR_2$ | 11.64 | 4.65 | 5.69 | 15.60 | 62.42 | 185 |

Generally, the application of soil conditioners under saline water led to increase the aggregate size and mean weight diameters of soil particles. Consequently, the increase in the soil aggregates percentages > 0.5 mm would improve the soil structure and decrease the susceptibility of the soil to erosion by wind and water, which are the major factors affecting agriculture activities.

From the above mentioned discussion it can be applied the tested soil conditioner particularly town refuse and bitumen for improving soil properties of newly reclaimed areas to achieve sustainable agriculture development.

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## أثر التحلل الحيوي لبعض محسنات التربة على خواص التربة تحت ظروف المياه المالحة

إسماعيل على عاشور، محمد حسين على ، فرح أبو السعود هاشم ، أسماء محمد سيد
قسم صيانة الأراضي -مركز بحوث الصحراء - المطرية- القاهرة

أقيمت تجربة أصص تحت الظروف المعملية لدراسة دور الكائنات الدقيقة الموجودة بالتربة على عملية التحلل الحيوي لبعض محسنات التربة وتهدف هذه الدراسة إلي معرفة التغيرات الطبيعية والكيميائية ، الميكروبيولوجيه للأراضي الجيرية نتيجة لإضافة هذه المحسنات إليها وتحليلها بفعل العوامل المؤثرة عليها كفترات التحضين ودرجات الحرارة. ويمكن تلخيص النتائج المتحصل عليها فيما يلي :

- أدت إضافة محسنات التربة وخاصة سماد مخلفات المدن إلى زيادة الأعداد البكترية الكلية وكمية ثاني أكسيد الكربون المتصاعد.
- أدي زيادة فترات التحضين ودرجات الحرارة بالتربة إلى زيادة كل أنواع الكائنات الدقيقة بعض النظر عن باقي المعاملات الاخرى.
- أدت إضافة محسنات التربة الى زيادة محتوى التربة الجيرية من الكربون العضوي وكانت معاملة التربة بالبيتيومين هي الافضل.
- أدت زيادة كل من درجات الحرارة وفترات التحضين إلى خفض قيم الكربون العضوي بالتربة نتيجة لدور هذه المعاملات فى زيادة النشاط الميكروبي بالتربة محل الدراسة.
- أدت إضافة محسنات التربة والتحضين على درجة حرارة ٣٠ °م لمدة ٩٠ يوم إلى حدوث زيادة فى قيم كل من النتروجين الكلي والأمونيومي والنتراتى عند استعمال ماء الري المالح.
- كذلك أدت إضافة محسنات التربة الى تحسن تجمعات التربة الأكبر من٠,٥مللتر مقارنة بالكنترول وبدرجة متفاوتة تبعا لتركيز و نوع المحسن.
- اختلف معدل التحلل للمحسنات المستخدمة تبعا لنوع المحسن المضاف وكان البيتيومين أكثرهم مقاومة للتحلل يليه البولي اكريلاميد ثم سماد مخلفات المدن.