ISSN: 0976-3031

Available Online at http://www.recentscientific.com

*International Journal of Recent Scientific Research*
*Vol. 6, Issue, 8, pp.5590-5595, August, 2015*

*International Journal of Recent Scientific Research*

RESEARCH ARTICLE

# PHYSICOCHEMICAL PROPERTIES OF CULTIVATED SOILS CONTAMINATED WITH MALATHION AND DURSBAN

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**ARTICLE INFO**

***Article History:***

Received 14th, July, 2015
Received in revised form 23th, July, 2015
Accepted 13th, August, 2015
Published online 28th, August, 2015

***Key words:***

Physicochemical, malathion, Bacterial density, dursban

**ABSTRACT**

The present study aimed to investigate the effects of soil physicochemical properties. soil pH, soil temperature, electrical conductivity, cations and anions, on the population of native Malathion – Dursbantolerant bacteria in the cultivated soils of six sites. The result showed that soil physical properties like temperature and electrical conductivity affect significantly to native malathion–dursbantolerant bacterial density. Similarly, the soil chemical properties like pH, cations and anions had more effect on the abundance of malathion-dursbantolerant bacteria in the soil. However, the impact of soil organic carbon, organic nitrogen and available phosphorus was very significant. The results of the present study can be utilized for the development of effective bioremediation process for pesticide-contaminated soil.



## INTRODUCTION

In the last decade and due to the increasing number of contaminants found in wastewater, surface water, ground water and soil, much attention need be given tohazardus chemical products such as pesticides that are present in soil which can have significant impacts and as a consequence on human health in the end. The World Health Organization (WHO) estimates that 3 million people are poisoned by pesticides every year, most of them in developing countries, and up to 20,000 person die each year from these victims [1].

Pesticides are widely studied as environmental contaminants because of their extensive use to the control pests affecting agricultural crops, homes, and gardens.Organophosphorous group forms a major and most widely used accounting for more than 36% of the total world market. Malathionand dursbanare one used intensively as an agricultural insecticide [2].

The objectives of this study were to examine the soil physicochemical properties influencing native malathion-dursbantolerant bacterial density in the cultivated soil and to as certain which physical and chemical properties of soil significantly influence the soil malathion-dursban tolerant bacterial population.

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## MATERIALS AND METHODS

### *Sample collection*

Thirty soil samples were collected from six different regions of probable contaminated sites by pesticides at different periods from 5/2/2014 to 2/8/2014 as in table1 for the isolation of bacteria. The samples were collected randomly from the superficial layer of soil (5-10cm) in depth, using pre-sterilized spatula and were transferred into sterilized bags, the samples were then air dried, sieved (2.0mm), and stored at $4^0$C storage until use.

**Table 1** Sampling locations and number of samples and isolates of each location site.

| Locations | Number of samples | Number of isolates |
|---|---|---|
| Baghdad aljededa | 5 | 8 |
| Al -karada | 4 | 4 |
| University campus | 4 | 11 |
| AL-Saydiya | 6 | 10 |
| AL-kathmya | 5 | 6 |
| Al –wazyria city | 6 | 6 |
| Total | 30 | 45 |

### *Physicochemical properties of soil*

The important physicochemical properties, viz., soil pH, electrical conductivity, cation, anion metal and available phosphate, nitrate,carbonate and bicarbonate of the soils used

for the screening of bacterial isolates were determined. The details of these methods are as described by APHA(2005).[3].

***Statistical analysis***

Least signification difference (LSD) was carried out using statistical package for social sciences (SPSS, Version 17.0). Analysis of variance (ANOVA), P – values, tests of significance, was carried out at 95% level of confidenceusing statistical package for social sciences. P – Values [* (P≤0.05), ** (P≤0.01)] were used to determine the significance levels between various treatments and data obtained during the experimental study [4].

## RESULTS AND DISCUSSIONS

***Soil physio-chemical properties***

Mean values ± standard deviation of soil pH, temperature (C°), EC (µs/cm), and both Dursban and Malathion (ppm) concentrations collected from six different locations within Baghdad province are given in table 2 which also gives the LSD value of each proper variable.

**Table 2** Mean values ± SD of soil pH, temperature (C°), EC (µs/cm), both dursban and malathion (ppm) concentrations and LSD value.

| Location | Sample No | Mean ± standard deviation | | | | |
|---|---|---|---|---|---|---|
| | | pH | Temperature C° | E.C µs/cm | **Dursban (ppm)** | **Malathion (ppm)** |
| Baghdad Aljededa | 5 | 8.5 ± 0.75 | 32.4 ± 5.5 | 118.0 ± 11.7 | 8.72 ± 3.14 | 2.01 ± 1.89 |
| Baghdad University | 4 | 7.6 ± 0.62 | 36.3 ± 1.3 | 464.0 ± 59.4 | 4.63 ± 1.83 | 1.47 ± 1.02 |
| AL-kathmya | 5 | 8.0 ± 0.36 | 33.3 ± 2.9 | 1006.6 ± 97.0 | 7.04 ± 1.5 | 0.39 ± 0.08 |
| AL-Saydiya | 6 | 7.72 ± 0.74 | 33.8 ± 3.4 | 70.67 ± 35.5 | 5.63 ± 2.7 | 0.97 ± 0.35 |
| Al karada | 4 | 7.88 ± 0.65 | 35.3 ± 4.5 | 276.5 ± 85.3 | 5.01 ± 2.87 | 0.8 ± 0.34 |
| Al –wazyria | 6 | 7.87 ± 0.67 | 39.5 ± 2.2 | 118.8 ± 9.14 | 5.83 ± 2.75 | 0.31 ± 0.14 |
| LSD | | 0.67 | 2.07 | 24.39 | 1.6 | 1.04 |

**pH**

This study has found that soil samples collected from Baghdad Aljededa had the highest (8.5 ± 0.75) pH mean value while the soil samples of Baghdad Universityrecorded gave the lowest (7.6 ± 0.62) mean value (Fig.1). Also, least significant difference test shows that several soil pH mean values were significantly (P≤ 0.05) differed from each other (Table 2).

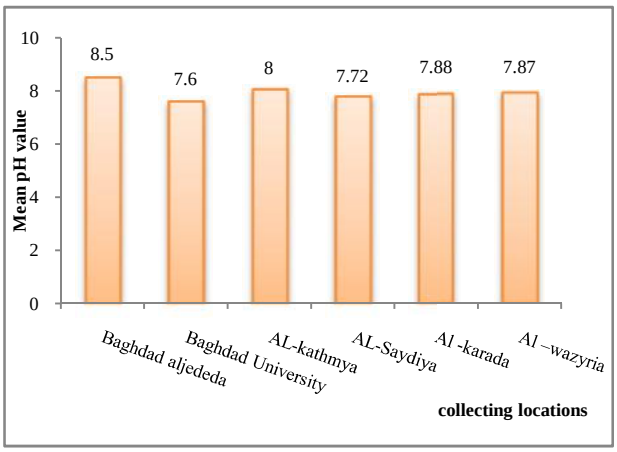


**Fig 1** Mean pH value of soil samples collected from six locations.

The pH of soil may affect pesticide degradation by altering the pesticide adsorption and also by influencing the microbial activity in the soil. Soil pH may also affect the mobility and bioavailability of pesticides. The effect of soil pH on degradation of a given pesticide depends greatly on whether the pesticide is susceptible to alkaline or acid catalyzed hydrolysis. The persistence of pesticides in soil is markedly influenced by the type ofsoil to which they are applied, and particularly by soil characteristics such as particle size, mineral and organic content and hydrogen ion concentration. Their residual life also depends upon the biological activity of the soil, since the breakdown patterns of many pesticides are mediated by enzymes.[5]

**Temperature**

This study has found that soil samples collected from Al –wazyria had the highest (39.5 ± 2.2) mean temperature value while the soil samples of Baghdad aljededa recorded the lowest (32.4 ± 5.5) mean value (Fig.2). Also, least significant difference test shows that several soil temperature mean values were significantly (P≤ 0.05) differed from each other (Table2).

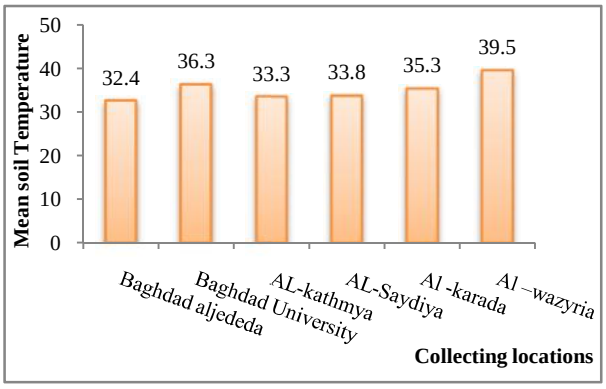


**Fig 2** Mean temperature value of soil samples collected from six locations.

The effect of temperature on the biodegradation of pesticide depends on the molecular structure of the pesticide. Temperature affects solubility, adsorption and hydrolysis of pesticides in soil. The activity of soil microorganisms is stimulated with the rise in temperature. The maximum growth and activity of microorganisms in soils are reported at 25°C to 35°C . It has been also reported that the pesticide degradation is optimal at temperature range of 25°C to 40°C[6].

**Electrical conductivity**

This study has found that soil samples collected from AL-kathmya had the highest (1006.6 ± 97.0) EC mean value while the soil samples ofAL-Saydiya recorded the lowest (70.67 ± 35.5) mean value (Fig.3). Also, least significant difference test shows that several soil Electrical conductivity mean values were significantly (P≤0.05) differed from each other (Table 2).

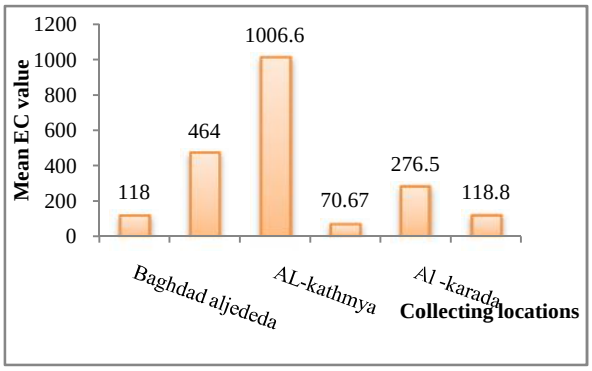


**Fig 3** Mean E.C. value of soil samples collected from six locations.

Therefore, it is clear that the soil physicochemical properties significantly affect the pesticide resistant bacterial diversity in the cultivated soil. The favorable oil properties are essential to ensure the presence of an active microbial population in the soil that can degrade pesticides[7].

**Dursban Residuals**

This study has found that soil samples collected from Baghdad aljededa had the highest (8.72 ± 3.14)dursban mean value while the soil samples of Baghdad University recorded the lowest (4.63 ± 1.83) mean value (Fig.4). Also, least significant difference test shows that several soil Durban Residuals mean values were significantly (P≤0.05) differed from each other (Table 2).

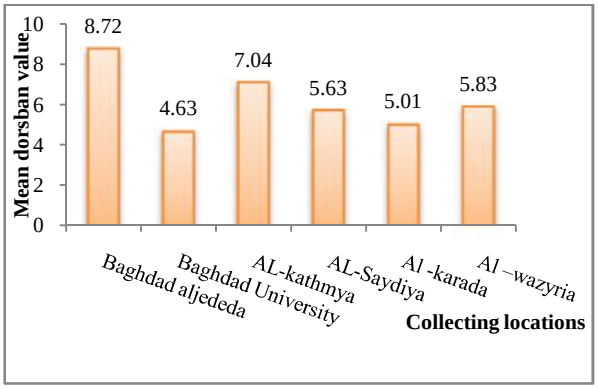


**Fig 4** Mean dorsban residuals (ppm) value of soil samples collected from six locations.

**Malathion Residuals**

This study has found that soil samples collected from Baghdad Aljededa had the highest (2.01 ± 1.89)malathion mean value, while the soil samples of Al –wazyriarecorded the lowest (0.31 ± 0.14) mean value (Fig.5). Also, least significant difference test shows that several soil Malathion Residuals mean values were significantly (P≤ 0.05) differed from each other (Table 2).

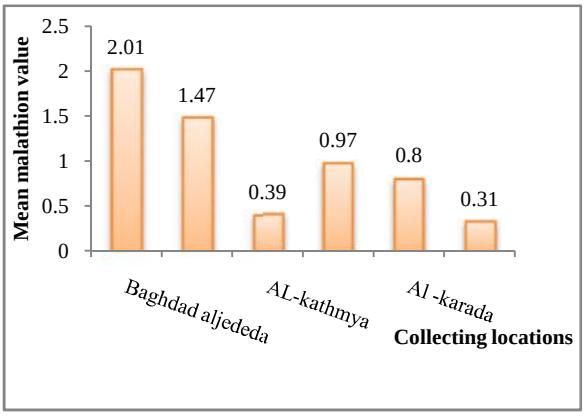


**Fig 5** Mean malathion residuals (ppm) value of soil samples collected from six locations.

**Soil Nutrient Ions**

Mean values ± standard deviation of $NO_3$, $PO_4$, $SO_4$, $HCO_3$, Cl, Ca, Mg, Na and K ions in different soil samples collected from six locations within Baghdad province are displayed in table 3.

**$NO_3$ Ions**

It has been found that the highest mean value of soil $NO_3$ ions was 44.9 ± 21.65 ppm in soil samples located in Al-Kathmya while the lowest mean value was 19.5 ± 16.02 ppm in Baghdad aljededa soil samples (Fig.6). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 3.57 ppm (Table 3).

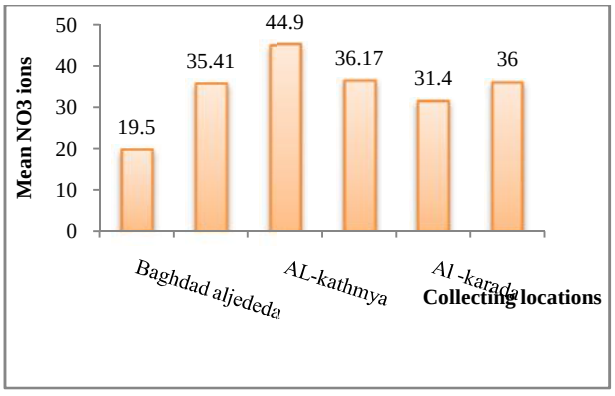


**Fig 6** Mean NO3 ions (ppm) value of soil samples collected from six locations.

Microbial activity is often stimulated by the addition of organic material tosoil. Organic matter like nitrat also improves many of the physical and chemical properties of soil such as the water holding capacity, aeration, pH, and ion exchange capacity. These properties influence the indigenous microbial populations and may enhance their ability to degrade hydrocarbons and other C-based contaminants[8].

**$PO_4$ Ions**

It has been found that the highest mean value of soil $PO_4$ ions was 903.54 ± 61.6ppm in soil samples located in Al-Kathmya while the lowest mean value was 3.26 ± 2.43ppm in Al -karada soil samples (Fig.7). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 24.45ppm (Table 3).

**Table 3** Mean values ± sd of $NO_3$, $PO_4$, $SO_4$, $HCO_3$, Cl, Ca, Mg, Na and K ions in different soil samples collected from six locations and LSD value of proper variable.

| Locations | Sample No. | Mean ± standard deviation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $No_3^-$ ppm | $Po_4^-$ ppm | $S0_4^-$ ppm | $Hco3^-$ppm | $CL^-$ ppm | $Ca^{++}$ ppm | $Mg^{++}$ ppm | $Na^+$ ppm | $K^+$ ppm |
| Baghdad aljededa | 5 | 19.5 ±16.02 | 15.92 ± 7.25 | 23.62 ± 21.6 | 231.88 ± 61.5 | 11.44 ± 5.27 | 9.8 ± 6.62 | 9.17 ± 8.93 | 2.08 ± 1.02 | 1.62 ± 1.99 |
| Baghdad University | 4 | 35.41 ± 21.7 | 121.12 ± 92.6 | 43.87 ± 10.71 | 216.28 ± 91.6 | 7.21 ± 5.23 | 50.35 ± 18.63 | 37.3± 16.6 | 1.4± 1.18 | 5.35 ± 2.04 |
| AL-kathmya | 5 | 44.9 ± 21.65 | 903.54 ± 61.6 | 480.9 ± 109.5 | 391.3 ± 161.4 | 10.9 ± 6.35 | 72.9± 34.56 | 26.9 ± 8.46 | 2.64 ± 1.68 | 4.84 ± 2.16 |
| AL-Saydiya | 6 | 36.17 ± 22.34 | 6.03 ± 3.63 | 2.24 ± 0.85 | 327.7 ± 144.8 | 7.88± 3.29 | 57.52 ± 48.08 | 9.85 ± 8.69 | 1.83 ± 1.71 | 2.55 ± 2.77 |
| Al -karada | 4 | 31.4 ± 19.6 | 3.26 ± 2.43 | 23.13 ± 16.6 | 394.6 ± 121.4 | 12.7 ± 6.43 | 39.7 ± 25.9 | 6.21 ± 3.39 | 2.15 ± 1.9 | 7.0 ± 0.43 |
| Al –wazyria | 6 | 36.0 ± 22.3 | 26.9 ± 20.96 | 3.6 ± 1.55 | 435.0 ± 156.7 | 12.17 ± 5.17 | 45.04 ± 37.4 | 4.5± 2.67 | 2.8 ± 1.52 | 4.65± 1.21 |
| LSD | | 3.57 | 24.45 | 17.78 | 12.34 | 1.96 | 5.94 | 4.72 | 0.93 | 1.81 |

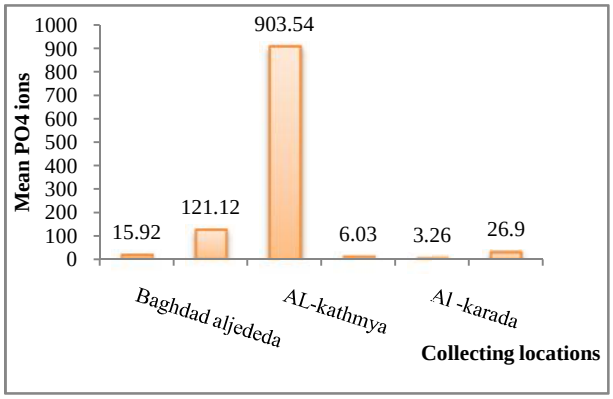


**Fig 7** Mean PO4 ions (ppm) value of soil samples collected from six locations.

## $SO_4$ Ions

It has been found that the highest mean value of soil $SO_4$ ions was 480.9 ± 109.5ppm in soil samples located in Al-Kathmya while the lowest mean value was 2.24 ± 0.85ppm in AL-Saydiya soil samples (Fig.8). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 17.78ppm (Table 3).

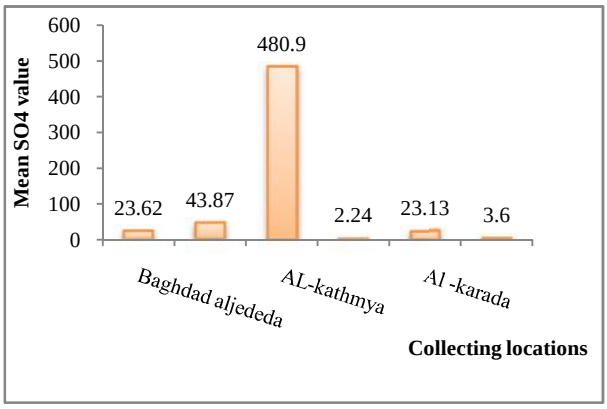


**Fig 8** Mean SO4 ions (ppm) value of soil samples collected from six locations.

Microorganisms differ in their needs to sulphur sources according totheir nature and growth requirements, in general organic nitrogen sources support growth and metabolism more than inorganic[8].

### $HCO_3$ Ions

It has been found that the highest mean value of soil $HCO_3$ ions was 435.0 ± 156.7ppm in soil samples located in Al –wazyria while the lowest mean value was 216.28 ± 91.6ppm in Baghdad University soil samples (Fig.9). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 12.34ppm (Table 3).

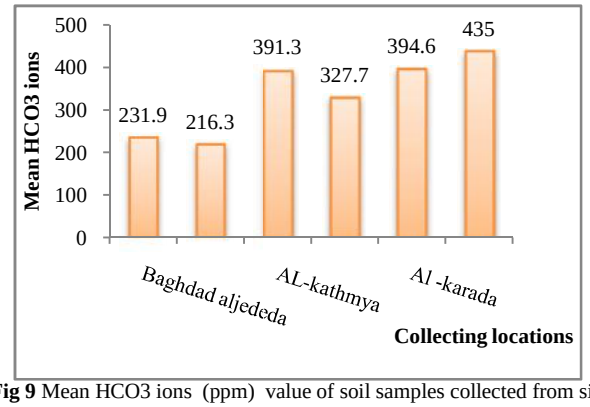


**Fig 9** Mean HCO3 ions (ppm) value of soil samples collected from six locations.

### Cl Ions

It has been found that the highest mean value of soil Cl ions was 12.7 ± 6.43ppm in soil samples located in Al -karada while the lowest mean value was 7.21 ± 5.23ppm in Baghdad University soil samples (Fig.10). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 1.96ppm (Table 3).

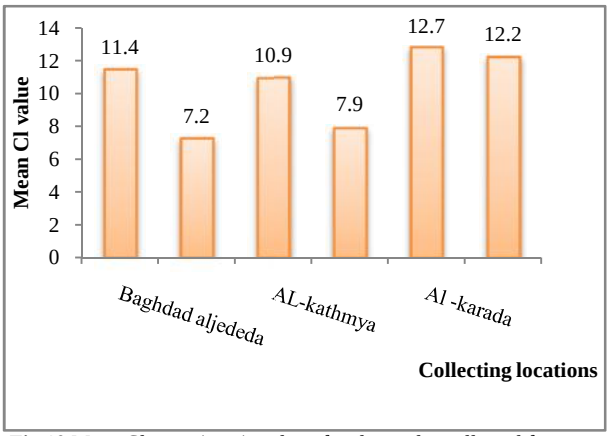


**Fig 10** Mean Cl ions (ppm) value of soil samples collected from six locations.

### Ca Ions.

It has been found that the highest mean value of soil Ca ions was 72.9 ± 34.56ppm in soil samples located in AL-kathmya while the lowest mean value was 9.8 ± 6.62ppm in Baghdad Aljededa soil samples (Fig.11). LSD test shows significant (P≤

0.05) differences between these data due to its value which was 5.94ppm (Table 3).

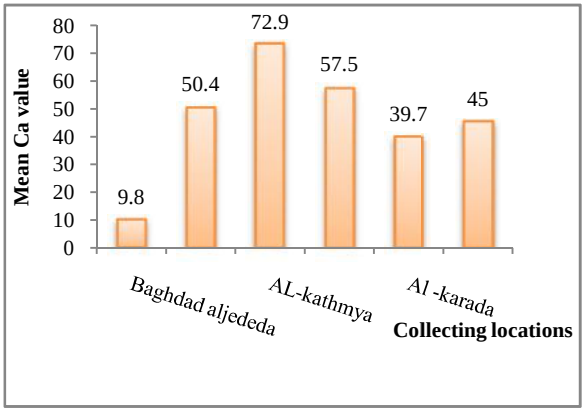


**Fig 11** Mean Ca ions (ppm) value of soil samples collected from six locations.

The incorporation of organic amendments affects soil enzyme that effect activities of microbial community because the added material may contain indoor extracellular enzymes and may also stimulate soil microbial activity In general, pesticide degradation in soil can be influenced byboth biotic and abiotic factors, which act in tandem and complement one another in the microenvironment [6].

## Mg Ions

It has been found that the highest mean value of soil Mg ions was 37.3 ± 16.6ppm in soil samples located in Baghdad University while the lowest mean value was 4.5 ± 2.67 ppm in Al–wazyria soil samples (Fig.12). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 4.72ppm (Table 3).

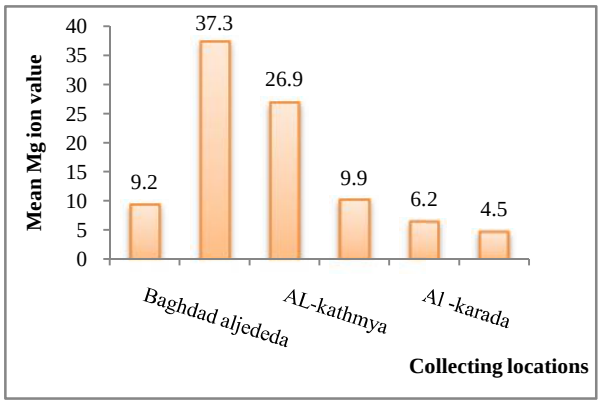


**Fig 12** Mean Mg ions (ppm) value of soil samples collected from six locations.

Pesticides added to soil can persist for a year or more. Sometimes, the lack of sufficient readily decomposable organic matter in soil gives inadequate substrate to stimulate microorganisms in the decomposition of pesticides. Present magnesium in soil to enhanced The vigorous biological activity during composting, this enhance the decomposition of pesticides in soil or deliberately to treat pesticide-contaminated materials[7].

## Na Ions

It has been found that the highest mean value of soil Na ions was 2.8 ± 1.52ppm in soil samples located in Al –wazyria while the lowest mean value was 1.4 ± 1.18ppm in Baghdad University soil samples (Fig.13). LSD test shows significant (P≤ 0.05) differences between these data due to its value which was 0.93ppm (Table 3).

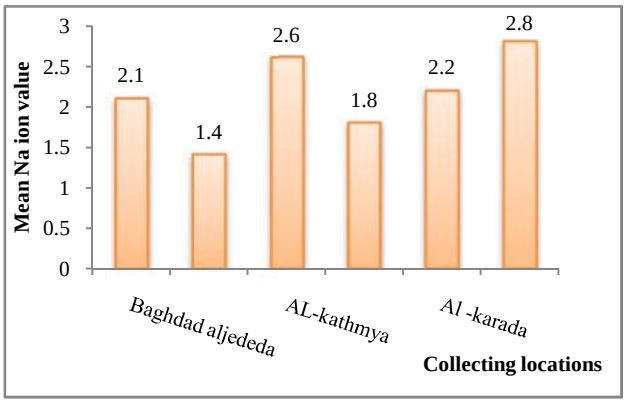


**Fig 13** Mean Na ions (ppm) value of soil samples collected from six locations.

In whole soil, nutrient limitations at low water content will restrict microbial processes , The studies of nutrient showed that water stress affected methane oxidation rates similarly in liquid cultures and in whole soils[9]. In many previous studies of water stress effects on physiology, salts were added to soil to show that the nitrification ratesand 2,4-D degradation rates decreased with decreasing waterpotential. Adjusting the salt concentration of soil slurries or pure liquid cultures alters the solute composition of water potential and may or may not also result in specific ion toxicity [10]. [10]reported that methane oxidation rates decreased with decreasing water potential when either salts (KCl or NaCl) or sugar (sucrose) were used to lower the solute or water potentials, respectively, of soil slurries.

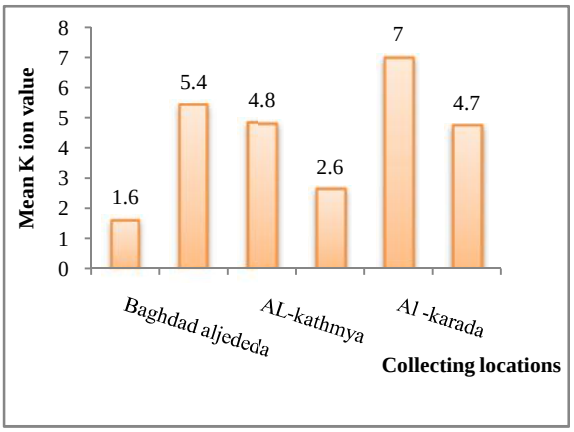


**Fig 14** Mean K ions (ppm) value of soil samples collected from six locations.

## K Ions.

It has been found that the highest mean value of soil Na ions was 7.0 ± 0.43ppm in soil samples located in Al -karada while the lowest mean value was 1.62 ± 1.99ppm in Baghdad Aljededa soil samples (Fig.14). LSD test shows significant (P≤

0.05) differences between these data due to its value which was 1.81ppm (Table 3).

The activity of important enzyme which used in biodegradation pesticide in soil increased by present mineral salts, these enzyme phosphotriestrase and dehydrogenase release by microbial activity[7].

## CONCLUSION

The present study showed that the soil physicochemical properties influence the abundance of native bacteria in the cultivated soil. Particularly, the effect of soil PH, soil organic carbon, organic nitrogen and available phosphorus, on the density of malathion-dursban tolerant bacteria in the soil, was very significant. Therefore, an effective management of soil by crop rotation, proper fertilization and nutrient recycling can have positive impact on the pesticide-tolerant bacterial population in the soil. These findings are useful for the development of effective bioremediation process for pesticide-contaminated soil.

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**How to cite this article:**

Faiza kadhim Emran and Hassanein Abood Hassoon., Physicochemical Properties Of Cultivated Soils Contaminated With Malathion And Dursban. *International Journal of Recent Scientific Research Vol. 6, Issue, 8, pp.5590-5595, August, 2015*

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