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MONITORING OF SOME SOIL MICROBES AND THEIR RELATIONSHIP TO SOIL SALINITY IN AL-HAMOUL REGION-KAFR EL-SHEIKH GOVERNORATE

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ABSTRACT

The soil samples were collected from the west to east side of the region. Most of the collected soil samples were highly saline, but salinity levels decreased as we headed east. The EC values ranged from 4014 t0 26.16. The viable counts of *R. leguminosarum* bv. *viceae, R. leguminosarum* bv. *trifolii* and *Azotobacte*r varied through different sites,they ranged from log to log 5.84; log 2.39 to 5.84; log 2.23 to 4.26, respectively and the variations between readings were ,sometimes, significant. But, there were no significant correlations between the estimated bacterial types and soil salinity. Total bacterial readings, however, showed high values, but, lowered in soil samples collected from the west sites.These bacterial counts were decreased as we headed east. They ranged from log 7.36 to log 9.46. However, there was no significant correlation between bacterial counts and soil salinity.

INTRODUCTION

Al-Hamool district located at North Delta region Kafr-El-Sheikh Governorate (31^{o} 15' 35'' N , 31^{o} 9' 36'' E), bounded from the North by Baltim and Burollos lake, from the South Bialla and Kafr-El-Sheikh Centers, from the East Bialla Center and from the West Kafr-El-Sheikh and Al-Riad Centers. The agricultural area was about 200,000 feddan and called Al-Hamool due to large growth of *Cuscuta epithymum* parasite plant (Hamoul). The lands of this area are newly reclaimed, some of which have low or moderate productivity and others still under reclamation. Its soils are saline and/or alkaline with varied degrees. The most problems of this area are salinity, alkalinity, low soil fertility and scarcity of low quality of irrigation water as this area is located at the end of irrigation and drainage canals. The fields have been irrigated with mixed polluted water composed from clean (Tera canal) and drainage water; sewage, industrial and agricultural (Ketchener drainage canal) with ratio of 1:1. This water is of low quality. Some of the fields irrigated totally with drainage water and others do not get enough water and suffer from drought.

A number of bacterial species belonging to genera *Azospirillum*, *Alcaligenes*, *Arthrobacter, Acinetobacter, Bacillus, Burkholderia, Enterobacter, Erwinia, Flavobacterium, Pseudomonas, Rhizobium and Serratia* are associated with the plant rhizosphere and are able to exert a beneficial effect on plant growth (Egamberdiyeva, 2005 and Tilak *et al.*, 2005). Utilization of plant growth promoting rhizobacteria (PGPR) in order to increase the productivity may be a viable alternative to organic fertilizers which also helps in reducing the pollution and preserving the environment in the spirit of an ecological agriculture (Stefan *et al.*, 2008). Thus rhizospheric bacteria can be a promising source for plant growth promoting agent in agriculture and are commonly used as inoculants for improving the growth and yield of agricultural crops(Chaiharn *et al.*, 2008). Biological nitrogen fixation contributes 180 X 10^6 metric tons/year globally, out of which symbiotic associations' produces 80% and the rest comes from free-living or associative systems (Graham, 1988).These include symbiotic nitrogen fixing (N_2-fixing) forms, viz. *Rhizobium*, the obligate symbionts in leguminous plants and Frankia in non-leguminous trees, and non-symbiotic (free-living, associative or endophytic) N_2-fixing forms such as cyanobacteria, *Azospirillum* and *Azotobacter*.

Agricultural crops are exposed to many stresses that are induced by both biotic and abiotic factors. These stresses decrease yields of crops and represent barriers to the introduction of crop plants into areas that are not suitable for crop cultivation. The occurrence and activity of soil microorganisms are affected by a variety of environmental factors as well as plant-related factors (species, age). Abiotic stress factors include high and low temperature, salinity, drought, flooding, ultraviolet light, air pollution (ozone) and heavy metals. The yield losses associated with abiotic stresses can reach 50% to 82%, depending on the crop. In many semi-arid and arid regions of the world, crop yield is limited due to increasing salinity of irrigation water as well as soil salinity. The inoculation of salt-stressed plants with PGPR strains alleviates the salinity stress in plants. Soil salinity is one of the most severe factors limiting nodulation, yield and physiological response in soybean. An increase in salinity in the soil causes a physiological response or disorder in lettuce plants (Han and Lee, 2005). The long-term goal of improving plant–microbe interactions for salinity affected fields and crop productivity can be met with an understanding of the mechanism of osmoadaptation in *Azospirillum* sp. The synthesis and activity of nitrogenases in *A. brasilense* is inhibited by salinity stress (Tripathi *et al.*, 2002). They reported that in *Azospirillum* sp. there is an accumulation of compatible solutes such as glutamate, proline, glycine betaine and trehalose in response to salinity/osmolarity; proline plays a major role in osmoadaptation through increase in osmotic stress that shifts the dominant osmolyte from glutamate to proline in *A. brasilense*. *Azospirillum*-inoculated sorghum plants had more water content, higher water potential, and lower canopy temperature in their foliage. Hence, they were less drought-stressed than noninoculated plants(Saleena *et al.*, 2002). The PGPR containing ACC deaminase (1-aminocyclopropane-1-carboxylate) are present in various soils and offer promise as a bacterial inoculum for improvement of plant growth, particularly under unfavourable environmental conditions such as flooding, heavy metals, phytopathogens, drought and high salt. Ethylene is an important phytohormone, but over-produced ethylene under stressful conditions can result in the inhibition of plant growth or death, especially for seedlings. PGPR containing ACC deaminase can hydrolyze ACC, the immediate precursor of ethylene, to F-ketobutarate and ammonia, and in this way promote plant growth. Inoculation of crops with ACC deaminase-containing PGPR may assist plant growth by alleviating deleterious effects of salt stress ethylene (Belimov *et al.*, 2001).

Microbial density in soil usually are correlated with organic matter percentage and sometimes biological inoculants such as N_2-fixing and phosphate-dissolving bacteria (Nour El-Din and Talha, 2011). They found, in long term experiment, that compost addition and inoculation with N_2-fixing and phosphate-dissolving bacteria enhanced soil organic matter percentage and available N,P and K contents. Miransari (2010), also claimed that biological fertilization caused increase of N and P as well as microelements in soil. On the other hand, there are some factors like salinity and heavy metals pollution negatively affecting microbial density of soil which may reflected on soil organic matter and nutrient contents.

The aim of the present investigation is the monitoring of viable counts of total bacteria, *R*. *leguminosarum* bv. *viceae*, *R*. *leguminosarum* bv. *trifolii* and *Azotobacter* in rhizosphere soil of Al-Hamoul Center, Kafr-El-Sheikh Governorate and their relationship with salinity level of soil, in order to give us an indicator for the soil quality and fertility.

MATERIALS AND METHODS

Materials:

Microbial media:

Medium 1 for counting of *Azotobacter*: Vancura and Mucura (1960), it composed of sucrose, 30 g; K_2HPO_4, 0.16 g; NaCl, 0.2 g; $MgSO_4$-$7H_2O$, 0.2 g; $CaCO_3$, 2.0 g; $FeSO_4$, 0.05 g; Na_2MO_4, 0.005 g; $NaBO_4$, 0.005 g and distilled water, 1 liter.

Medium 2: for total counting of bacteria (Allen, 1959)

Glucose, 15.0 g; K_2HPO_4, 1.0g; soil extract, 100 ml; distilled water, 900 ml, agar, 15 g; pH adjusted at 6.8- 7.0. Autoclaved at 121◦ C for 15 min.

Soil extract:

Soil extract is prepared by heating 1000 g of grinding soil with 1000 ml of tap water in the autoclave for 30 minuts. A small amount of calcium carbonate (2.5 g/l) is added on the soil suspension and filtered through a double paper filter. The filtrate was divided into quantities each equal 100 ml and then sterilized.

Methodes:

Site of samples: soil and plant (faba bean and Egyptian clover) samples sites were determined using the detailed spatial map of Al-Hamool district, as the samples designed every 2 km with the rate of one composite sample per 250 km^2.

Soil sampling: Using spade, the soil bulk around the plant (30cm depth) was removed and backed in plastic bags. Three faba bean samples were taken from each field and other three samples of *Trifolium Alexandrinum* were bring as possible from the same site. Different microbial groups were counted (total count of bacteria, *Azotobacter R. leguminosarum* biovar *viceae and R. leguminosarum* biovar *trifolii*).

***R. leguminosarum* biovar *viceae and R. leguminosarum* biovar *trifolii* count in soil**: The counting was done using MPN technique reported by Somasegaran an Hoben (1985).

***Azotobacter* count:** MPN method, using medium of Vancura and Mucura (1960) was performed according to Allen (1959).

Total count of bacteria:

Soil extract solidified medium was poured in Petri dishes, then inoculated with the appropriate dilutions of the soil samples and incubated at 28^oC for three days. The appeared colonies were counted and the count per 1 g air dry soil was calculate as reported by Allen, (1959).

EC: EC of soils were estimated according to Richards (1954).

Statistical analysis:

Data obtained were subjected to the analysis of variance and treatment means were compared using the L.S.D methods according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Through monitoring EC values (dS/m) for soils of many villages of Al-Hamoul Center, Kafr El-Sheikh Governorate (Table 1), it is noted that most of soil samples brought about from the Eastern villages recorded higher EC values (the first 20 sample), and their EC values ranged from 7.40 to 12.71 dS/m. However, the EC values of the collected samples lowered with the direction of west, the EC values of the following twenty western sites ranged from 4.35 to 10.60 dS/m except for two sites (No. 35 and 36) which were estimated as 26.16 and 23.65 dS/m respectively. The following last twenty samples from the western direction recorded the lowest EC values, ranged from 4.16 to 7.11 dS/m except the sites No. 52 and 53 which was of relatively high records (9.7 and 10.32 dS/m).

The Al-Hamoul region consider from the sites under reclamation in Kafr El-Sheikh Governorate. Soil of some locations were reclaimed and others still had high salinity nature. The west site is the nearest from Al-bourolos Lake and most of its fields used as fish cultures, and others recently used as agricultural fields. Therefore, salinity levels in this fields still high. With the progress toward east, the soils have been reclaimed and their EC values lowered except some fields that may be neglected by farmers. The main difficulty of reclamation of these soils is the use of drainage water in irrigation (Zein *et al.*, 2002).

The results of monitoring *R. leguminosarum* biovar *viceae* and *R. leguminosarum* biovar *trifolii* of Al-Hamoul soils relatively varied, and there are significant variations between most of these records (Table 2 and 3). However, there was no significant correlation between salinity levels of soil samples and log number of these microbes (Fig 1). The lowest monitored *R. leguminosarum* biovar *viceae* count was log 4.00 soil sample No. 49, while, the highest count recorded log 5.84 which repeated frequently at many sites of the studied area. On the other hand, the lowest number of *R. leguminosarum* biovar *trifolii* (log 2.39) was recorded for soil sample No. 24 and the highest value were 5.84 which recorded at many sites of the studied area.

The high counts of native *R. leguminosarum* biovar *viceae* and *R. leguminosarum* biovar *trifolii* may be attributed to continuous cultivation of faba bean and Egyptian berseem since long period, therefore the indigenous specific rhizobia spread and localized in soils of the region.

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The macro-symbiont plants brought from the region were well nodulated (not presented data) which explains the potentiality of these rhizobia for root infection and formation of nodules. Nour El-Din (1997) reported that the fields had been cultivated with *Trifolium alexandrinum* or *Vicia faba* had high density of the specific native rhizobia. But, in the present study there were no significant correlation between the counts of the microsymbionts in the plants rhizosphere and the salinity levels of the soil samples. This may be attributed to two reasons: the first is the formation of mutations in the native rhizobial populations lead to presence of new salt tolerant strains potentially able to live effectively under these stress conditions (Zahran, 1999). The second reason is that fields of this region had been irrigated with sewage water which have a lot of nutrients and organic matter, which enriched the soil and increased the soil water holding capacity (Mohammed, 2011). Wei *et al.* (1985) claimed that sewage sludge application to agricultural soils is an economical way of disposal. It improves the physical characteristics of the soil and increases organic matter content and essential plant nutrients, in particular N and P (Ferreira *et al.*, 1995). Sewage sludge contains numerous components required for microbial growth and may increase the activity of soil microorganisms (Speaker *et al.*, 1988), including rhizobial growth. But, the heavy amounts of sewage amendments for long times may negatively affect N_2-fixers effeciency which may attributed to high amounts of heavy metals (Chaudhary *et al.*, 2004) and increase amounts of nitrates (Obbard *et al.*, 1993).

Azotobacter viable counts were more less numbers per gm of rhizosphere soil than *R. leguminosarum* biovar *viceae* and *R. leguminosarum* biovar *trifolii*, the counts ranged from log 2 to log 4.26 (Table, 4). As found for counts of *R. leguminosarum* biovar *viceae* and *R. leguminosarum* biovar *trifolii*, there was no positive correlation between the *Azotobacter* counts and salinity degrees (Fig, 1). In case of total bacteria, the counts increased as we head east of the province (Table 5), whereas, the first 20 samples brought about from the far west of the province (Al-Hamoul Center) mostly gave relatively low counts (less than log 8), while most of the following 20 samples toward east, recorded counts more than log 8, but, the following 20 samples toward east (from sample No. 41 to No. 60) attained the highest numbers (mostly higher than log 8.7) and there were significant variation between most samples. However, there was no significant correlation between the bacterial counts and soil salinity levels. The lower viable counts of *Azotobacter* than rhizobial counts may be due to the direct contact of *Azotobacter* cells with salty and heavily polluted soils with heavy metals because of the irrigation with sewage water (Zein *et al.*, 2002). Rhizobia harbored within nodules gave them relative protection against salinity and heavy metals. On the other hand, extensive planting of the host macrosymbiont plants resulted in increase of the specific rhizobia in the soil. Total bacterial counts noted to be lower in soil of west sites which were close to Al-Brolos lake, and had no enough reclamation, therefore the soils still highly saline as shown in Table 1. The deleterious effect may result from sensitivity of some sensitive bacterial types to unfavorable conditions which may lead to decrease of total count.

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The total bacterial counts increased as we head east, this may be due to increase of reclamation efforts as we head east of the region.

CONCLUSION

Al-Hamoul region is of the locations recently reclaimed, thus, there were variations in its soils fertility. Monitoring of soil salinity and microbial biomass of these soils are of important which give us an indicator for soil quality and fertility. The survey indicated that most of west sites are highly in salin than the other sites of the region. The *R. leguminosarum* bv. *viceae*, *R. leguminosarum* bv. *trifolii* and *Azotobacter* were tolerant to salinity and other unfavorable environmental conditions. The total bacterial counts mostly varied. This area needs clean irrigation water and more effective reclamation processes to increase the economic value of unit area and improve living level of the inhabitants.

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رصد أعداد ميكروبات التربة المثبتة للازوت الجوي وعلاقتها ببعض خصائص التربة بمنطقة الحامول – محافظة كفرالشيخ

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مركز البحوث الزراعية-معهد بحوث الاراضي و المياه والبيئة-الجيزة-القاهرة

يقع مركز الحامول بالمنطقة الشمالية الغربية من محافظة كفرالشيخ, وتبلغ مساحة الاراضي الصالحة للزراعة بالمركز حوالي 200000 فدان, وهذه الاراضي حديثة الاستصلاح, فمنها من تم استصلاحة والاخر مازال تحت الاستصلاح. وتقع أراضي مركز الحامول في نهاية الترع والمصارف, لذلك فانها تعاني من ندرة مياه الري النظيفة, وتروي هذه الاراضي اما بمياه الصرف (صحي وزراعي وصناعي) أو بالمياه المخلوطة من مياه ترعة بحر تيرة النظيفة ومياه مصرف كتشنر الملوثة والغير معالجة, مما يجعل الاراضي بهذه المنطقة تعاني من الملوحة والتلوث بالعناصر الثقيلة وكذلك الميكروبات الممرضة. لذلك فاننا نهدف في هذه الدراسة الي رصد لحالة التربة بهذه المنطقة من ناحية درجات ملوحتها واعداد بعض الميكروبات المهمة بمنطقة جذور نباتي البرسيم المسقاوي و الفول البلدي, كي تعطينا مؤشرا عن حالة هذه الاراضي و مدي خصوبتها.

كانت معظم العينات المجلوبة من مركز الحامول عالية الملوحة, وكانت ملوحة الاراضي تقل كلما اتجهنا ناحية الشرق, وقد وجد تباين في أعداد ميكروبات الازوتوباكتر و ريزوبيا الفول البلدي و ريزوبيا البرسيم المسقاوي من موقع الي اخر. وعلي الرغم من وجود هذه الاعداد بوفرة, فلم يظهر ارتباط معنوي بين هذه الاعداد و قيم ملوحة التربة . كانت اعداد البكتريا الكلية بالتربة كبيرة نسبيا, ولكنها كانت أقل كلما تجهنا ناحية الغرب. أيضا لم يوجد ارتباطا معنويا بين الاعداد الكلية للبكتيريا بالتربة و قيم الملوحة لها. لذلك فاننا نوصي بتوصيل مياه الري النظيفة لهذه المنطقة للتقليل من ملوحة الاراضي و زيادة انتاجيتها و كذلك تقليل تلوث الاراضي والمزروعات بالعناصر الثقيلة والميكروبات الممرضة بهدف حماية الصحة العامة زيادة انتاجية الفدان لهذه المنطقة المنكوبة.

قام بتحكيم البحث

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Table 1: Monitoring of soil samples EC, dS/m, (soil extract) collected from Al-Hamoul region.

Sample No.	Coordination		EC	Sample No.	Coordination		EC	Sample No.	Coordination		EC
	X	Y			X	Y			X	Y	
1	-	-	10.86b-h	21	36316881	3477281	6.45f-p	41	36316713	3473392 7M	4.16p
2	-	-	10.75b-i	22	36315996	3479831	10.27b-l	42	36317495	3474084 0M	3.91p
3	-	-	13.03bc	23	36313874	3480536	11.11b-g	43	36317650	3475284 1M	4.23op
4	-	-	12.07b-e	24	36313078	3481430	7.78c-p	44	36316248	3475908 3M	5.22i-p
5	-	-	9.37b-p	25	36313735	3458684	6.69e-p	45	36317861	3478603 1M	4.35p
6	-	-	8.89b-p	26	36314878	3458374	6.53f-p	46	36316130	3480175 0M	4.16k-p
7	-	-	11.48b-f	27	36317668	3462242	6.97e-p	47	36317019	3481278 0M	4.58m-p
8	-	-	11.50b-f	28	36317452	3463880	5.76g-p	48	36315937	3482127 0M	4.93k-p
9	-	-	11.26b	29	36321940	3463489	5.63g-p	49	36315364	3483449 0M	5.00k-p
10	36314240	3460498	13.60bc	30	36320274	3467906-2M	4.93k-p	50	36316241	3482830 0M	6.47f-p
11	36315502	3465810	7.43d-p	31	36318913	3467955-2M	4.80 l-p	51	36317659	3482824 14M	7.11e-p
12	36315512	34674	7.40d-p	32	36318068	3470039-0M	4.96k-p	52	36318104	3484566 0M	9.70b-o
13	36315550	3468466	8.42b-p	33	36317341	3471505	4.35nop	53	36318188	3486721 0M	10.32b-k
14	36314602	3468121	12.03b-f	34	36317284	3473841-1M	10.60b-m	54	36318138	3486720 0M	6.32f-p
15	36314220	3465207	13.36b	35	36317705	3476831-9M	26.16a	55	36319642	3459192 2M	4.96k-p
16	36314275	3469753	12.66bcd	36	36315577	3476332-2M	23.65a	56	36322277	3460195 9M	4.65m-p
17	36310576	3472265	12.71bcd	37	36316411	3481142-1M	9.79b-n	57	36322180	3460195 0M	4.75m-p
18	36307598	3472499	8.06b-p	38	36311349	3477764 0M	6.53f-p	58	36321179	3463170 0M	4.97k-p
19	36317091	3473117	7.70d-p	39	36312539	3476611 2M	5.35i-p	59	36321847	3460740 0M	5.42h-p
20	36317158	33474928	7.14e-p	40	36313704	3475522 0M	5.19j-p	60	36321663	3461802 3M	4.76 l-p

Means with different letters differ significantly at P < 0.05.
Coordenation: is the reading of X and Y taking by GPS device.

Table 2: Monitoring number (log) of soil samples *R. leguminosarum* biovar *viceae* (R.V.) collected from Al-Hamoul region.

Sample No.	Coordination		R.V.	Sample No.	Coordination		R.V.	Sample No.	Coordination		R.V.
	X	Y			X	Y			X	Y	
1	-	-	5.31c-f	21	36316881	3477281	5.84abc	41	36316713	3473392 7M	5.02c-g
2	-	-	5.31c-f	22	36315996	3479831	5.84abc	42	36317495	3474084 0M	5.02c-g
3	-	-	5.84abc	23	36313874	3480536	5.84abc	43	36317650	3475284 1M	5.04c-g
4	-	-	5.84abc	24	36313078	3481430	5.65bcd	44	36316248	3475908 3M	5.55b-e
5	-	-	5.84abc	25	36313735	3458684	5.55b-e	45	36317861	3478603 1M	5.02c-g
6	-	-	5.84abc	26	36314878	3458374	5.55b-e	46	36316130	3480175 0M	5.02c-g
7	-	-	5.31c-f	27	36317668	3462242	4.75d-g	47	36317019	3481278 0M	5.26c-g
8	-	-	5.31c-f	28	36317452	3463880	4.23fg	48	36315937	3482127 0M	4.51efg
9	-	-	5.31c-f	29	36321940	3463489	5.84abc	49	36315364	3483449 0M	4.00g
10	36314240	36314240	5.31c-f	30	36320274	3467906-2M	5.84abc	50	36316241	3482830 0M	5.04c-g
11	36315502	36315502	5.84abc	31	36318913	3467955-2M	5.84abc	51	36317659	3482824 14M	5.84abc
12	36315512	36315512	5.84abc	32	36318068	3470039-0M	5.84abc	52	36318104	3484566 0M	5.84abc
13	36315550	36315550	5.84abc	33	36317341	3471505	5.55b-e	53	36318188	3486721 0M	5.84abc
14	36314602	36314602	5.04c-f	34	36317284	3473841-1M	5.26c-f	54	36318138	3486720 0M	5.84abc
15	36314220	36314220	4.54c-g	35	36317705	3476831-9M	5.55b-e	55	36319642	3459192 2M	5.84abc
16	36314275	36314275	4.82c-g	36	36315577	3476332-2M	5.84abc	56	36322277	3460195 9M	5.84abc
17	36310576	36310576	5.31c-f	37	36316411	3481142-1M	5.04c-g	57	36322180	3460195 0M	5.84abc
18	36307598	36307598	5.04c-g	38	36311349	3477764 0M	5.04c-g	58	36321179	3463170 0M	5.84abc
19	36317091	36317091	4.23g	39	36312539	3476611 2M	5.04c-g	59	36321847	3460740 0M	5.84abc
20	36317158	36317158	5.04c-g	40	36313704	3475522 0M	4.77d-g	60	36321663	3461802 3M	5.84abc

Means with different letters differ significantly at P < 0.05.
Coordenation: is the reading of X and Y taking by GPS device.

Table 3: Monitoring number (log) of soil samples *R. leguminosarum* biovar *trifolii* (R.T.) collected from Al-Hamoul region.

Sample No.	Coordination		R.T.	Sample No.	Coordination		R.T.	Sample No.	Coordination		R.T.
	X	Y			X	Y			X	Y	
1	-	-	5.31abc	21	36316881	3477281	5.04a-f	41	36316713	3473392 7M	5.02c-g
2	-	-	5.84a	22	36315996	3479831	4.77b-g	42	36317495	3474084 0M	5.02c-g
3	-	-	5.84a	23	36313874	3480536	4.77b-g	43	36317650	3475284 1M	5.04c-g
4	-	-	5.84a	24	36313078	3481430	2.39b-g	44	36316248	3475908 3M	5.55b-e
5	-	-	5.55ab	25	36313735	3458684	3.58hij	45	36317861	3478603 1M	5.02c-g
6	-	-	5.38abc	26	36314878	3458374	4.50c-h	46	36316130	3480175 0M	5.02c-g
7	-	-	4.77b-g	27	36317668	3462242	4.23f-i	47	36317019	3481278 0M	5.26c-g
8	-	-	5.31abc	28	36317452	3463880	3.50ij	48	36315937	3482127 0M	4.51efg
9	-	-	5.31abc	29	36321940	3463489	4.30d-i	49	36315364	3483449 0M	4.00g
10	36314240	36314240	5.31abc	30	36320274	3467906-2M	5.84a	50	36316241	3482830 0M	5.04c-g
11	36315502	36315502	5.31abc	31	36318913	3467955-2M	5.84a	51	36317659	3482824 14M	5.84abc
12	36315512	36315512	5.31abc	32	36318068	3470039-0M	5.31abc	52	36318104	3484566 0M	5.84abc
13	36315550	36315550	5.84a	33	36317341	3471505	4.27e-j	53	36318188	3486721 0M	5.84abc
14	36314602	36314602	4.80b-g	34	36317284	3473841-1M	4.00g-j	54	36318138	3486720 0M	5.84abc
15	36314220	36314220	4.30d-i	35	36317705	3476831-9M	5.04a-f	55	36319642	3459192 2M	5.84abc
16	36314275	36314275	4.30d-i	36	36315577	3476332-2M	5.84a	56	36322277	3460195 9M	5.84abc
17	36310576	36310576	4.00g-j	37	36316411	3481142-1M	5.31abc	57	36322180	3460195 0M	5.84abc
18	36307598	36307598	4.23f-i	38	36311349	3477764 0M	4.77b-g	58	36321179	3463170 0M	5.84abc
19	36317091	36317091	4.23f-i	39	36312539	3476611 2M	4.50c-h	59	36321847	3460740 0M	5.84abc
20	36317158	36317158	5.04a-f	40	36313704	3475522 0M	4.50c-h	60	36321663	3461802 3M	5.84abc

Means with different letters differ significantly at $P < 0.05$.
Coordenation: is the reading of X and Y taking by GPS device.

Table 4: Monitoring number (log) of soil samples *Azotobacter* (Az.) collected from Al-Hamoul region.

Sample No.	Coordination		Az.	Sample No.	Coordination		Az.	Sample No.	Coordination		Az.
	X	Y			X	Y			X	Y	
1	-	-	3.00c-f	21	36316881	3477281	4.26a	41	36316713	3473392 7M	2.76
2	-	-	3.00c-f	22	36315996	3479831	4.00a	42	36317495	3474084 0M	2.76
3	-	-	3.50abc	23	36313874	3480536	3.00c-f	43	36317650	3475284 1M	2.50
4	-	-	3.50abc	24	36313078	3481430	2.26ef	44	36316248	3475908 3M	2.50
5	-	-	3.23b-e	25	36313735	3458684	3.26b-e	45	36317861	3478603 1M	2.26
6	-	-	3.00c-f	26	36314878	3458374	3.50c-f	46	36316130	3480175 0M	2.76
7	-	-	2.76c-f	27	36317668	3462242	2.50c-f	47	36317019	3481278 0M	2.50
8	-	-	2.75c-f	28	36317452	3463880	3.00c-f	48	36315937	3482127 0M	2.73
9	-	-	2.50c-f	29	36321940	3463489	3.00c-f	49	36315364	3483449 0M	3.23
10	36314240	36314240	2.73c-f	30	36320274	3467906-2M	2.76c-f	50	36316241	3482830 0M	3.00
11	36315502	36315502	3.00c-f	31	36318913	3467955-2M	3.26ef	51	36317659	3482824 14M	2.76
12	36315512	36315512	2.76c-f	32	36318068	3470039-0M	2.76c-f	52	36318104	3484566 0M	2.26
13	36315550	36315550	2.50c-f	33	36317341	3471505	3.26b-e	53	36318188	3486721 0M	2.26
14	36314602	36314602	2.23ef	34	36317284	3473841-1M	2.76c-f	54	36318138	3486720 0M	2.76
15	36314220	36314220	2.73c-f	35	36317705	3476831-9M	2.26ef	55	36319642	3459192 2M	3.00
16	36314275	36314275	2.73c-f	36	36315577	3476332-2M	3.26b-e	56	36322277	3460195 9M	3.23
17	36310576	36310576	2.22ef	37	36316411	3481142-1M	3.50abc	57	36322180	3460195 0M	3.23
18	36307598	36307598	2.50c-f	38	36311349	3477764 0M	2.23ef	58	36321179	3463170 0M	3.00
19	36317091	36317091	3.00-f	39	36312539	3476611 2M	2.23ef	59	36321847	3460740 0M	2.76
20	36317158	36317158	3.50c-f	40	36313704	3475522 0M	2.00ef	60	36321663	3461802 3M	2.50

Means with different letters differ significantly at P < 0.05.
Coordenation: is the reading of X and Y taking by GPS device.

Table 5: Monitoring number (log) of soil samples total bacteria (T.B.) collected from Al-Hamoul region.

Sample No.	Coordination		T.B.	Sample No.	Coordination		T.B.	Sample No.	Coordination		T.B.
	X	Y			X	Y			X	Y	
1	-	-	7.57pqr	21	36316881	3477281	8.07m-q	41	36316713	3473392 7M	9.12a-g
2	-	-	7.57pqr	22	36315996	3479831	8.06n-q	42	36317495	3474084 0M	9.22a-e
3	-	-	8.09m-q	23	36313874	3480536	8.12 l-p	43	36317650	3475284 1M	9.37abc
4	-	-	8.2 l-p	24	36313078	3481430	8.13 l-	44	36316248	3475908 3M	9.14a-f
5	-	-	8.1 l-p	25	36313735	3458684	8.1l-p	45	36317861	3478603 1M	8.93b-h
6	-	-	7.39pqr	26	36314878	3458374	8.04 n-q	46	36316130	3480175 0M	9.1a-h
7	-	-	8.16 l-p	27	36317668	3462242	8.15 l-p	47	36317019	3481278 0M	9.58a
8	-	-	8.36i-n	28	36317452	3463880	8.22k-p	48	36315937	3482127 0M	9.34abc
9	-	-	7.57qr	29	36321940	3463489	8.12 l-p	49	36315364	3483449 0M	8.81d-j
10	36314240	36314240	7.36r	30	36320274	3467906-2M	8.34j-o	50	36316241	3482830 0M	8.21 l-p
11	36315502	36315502	7.81o-r	31	36318913	3467955-2M	8.34j-o	51	36317659	3482824 14M	8.22k-p
12	36315512	36315512	7.78pqr	32	36318068	3470039-0M	8.11 l-p	52	36318104	3484566 0M	8.82d-j
13	36315550	36315550	7.75pqr	33	36317341	3471505	8.62f-l	53	36318188	3486721 0M	8.78d-j
14	36314602	36314602	7.67pqr	34	36317284	3473841-1M	8.38 i-n	54	36318138	3486720 0M	8.88c-i
15	36314220	36314220	7.62pqr	35	36317705	3476831-9M	8.61g-l	55	36319642	3459192 2M	8.83d-j
16	36314275	36314275	7.92n-q	36	36315577	3476332-2M	9.43ab	56	36322277	3460195 9M	8.78d-j
17	36310576	36310576	7.86n-r	37	36316411	3481142-1M	9.37ab	57	36322180	3460195 0M	8.77d-j
18	36307598	36307598	7.77pqr	38	36311349	3477764 0M	9.37abc	58	36321179	3463170 0M	8.58h-m
19	36317091	36317091	7.8pqr	39	36312539	3476611 2M	9.46a	59	36321847	3460740 0M	8.72e-k
20	36317158	36317158	7.94n-q	40	36313704	3475522 0M	9.26ab	60	36321663	3461802 3M	8.77d-j

Means with different letters differ significantly at P < 0.05.
Coordenation: is the reading of X and Y taking by GPS device.

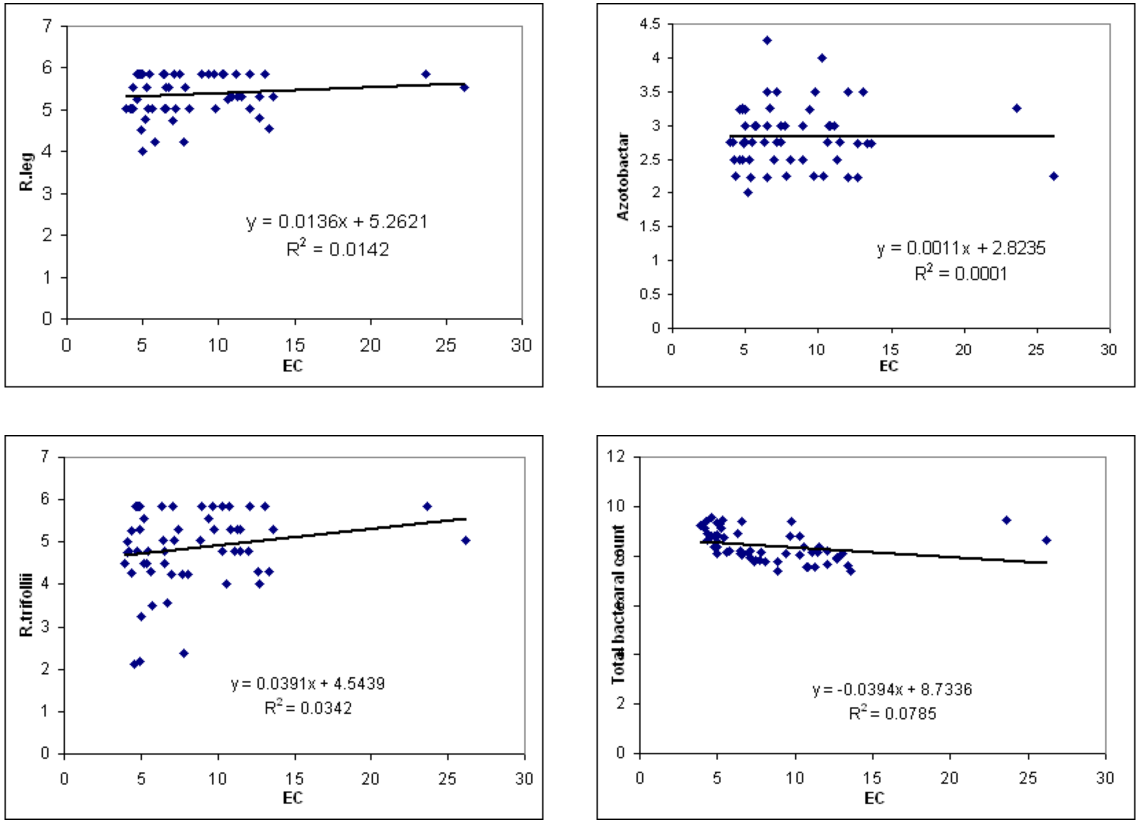

Figure 1: Correlations between salinity and log numbers of different studied microbes.